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## REVISITING *NEPHRODOPUS* SHARP, 1873, WITH THE DESCRIPTION OF A NEW SPECIES AND A FEMALE (COLEOPTERA: SCARABAEIDAE: DYNASTINAE)

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### Abstract

The female of the Australian dynastine scarab *Nephrodopus enigma* Sharp, 1873, is described. A previous designation of a lectotype for *N. enigma* is rejected as unnecessary, but a lectotype is designated for *Nephrodopus enigma niger* Lea, 1917. *Nephrodopus goldingi* sp. n. is described from the edges of the Great Sandy Desert of Western Australia. A revised diagnosis of the genus is presented to accommodate the new species and the female, and a key to males is presented. Images of *Nephrodopus* adults are provided to illustrate their unique characters, particularly the highly modified mouthparts.

### Introduction

*Nephrodopus* was erected by Sharp (1873) to accommodate a specimen from Cape York in northern Queensland with two unique characters: ‘mentum in lamina porrecta perpendicular descendente production’ and ‘elytra brevia, maris pone scutellum breviter cornuta!’ He named this novel species *Nephrodopus enigma*, as it had characters that did not neatly conform to those of either the Pimelopides or Oryctomorphides (as then understood). The species is known from Bowen northwards in northeastern Queensland across Cape York Peninsula and into northern Northern Territory (Carne 1957, Dechambre 2005). Since Carne’s revision, the genus has been placed in the tribe Pentodontini, subtribe Pseudoryctina, *sensu* Smith (2006).

A second taxon, *Nephrodopus thauma*, was described by Prell (1912) from a single male from an unknown Australian location. A further taxon, *Nephrodopus enigma* var. *niger* was described by Lea (1917) from ‘black’ males from Alligator River, Northern Territory; Carne (1957), Endrödi, (1974), Cassis and Weir (1992) and Dechambre (2005) treated both of these taxa as junior synonyms of *N. enigma*.

Carne (1957) discussed the variability among specimens of *N. enigma* in colour, length of the antennal club and shape of the maxillary palpi. He noted four forms and both the bicolorous and black forms were illustrated by Dechambre (2005). However, given the overlapping distributions and the paucity of specimens, Carne was hesitant to describe them as more than forms. To date, females have not been described and generic characters used by previous authors have been restricted to the unique characters exhibited in males. The access to a female specimen allows us to describe it and reassess generic characters that are gender specific.

A small series of males from the edges of the Great Sandy Desert in Western Australia has the very compressed, vertical mentum and ligula and the enlarged maxillary palpi unique to *Neprodopus* but is obviously distinct from *N. enigma*. We describe it here. The series also exhibits variable characters, such as colour forms and shape of the maxillary palpi, similar to what Carne described in *N. enigma*.

### Materials and methods

*Species concept and nomenclature.* Our criteria for delimiting species are based on those published by Wheeler and Platnick (2000), whose phylogenetic species concept defines species as the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of characters. We also consider the description of a new 'variety' by Lea (1917) as intending a subspecific taxon (Article 45.6.4, ICZN 1999).

*Illustrations.* PMH examined specimens of the new species using a Nikon SMZ 745 Microscope. Photographs were taken with a Canon EOS 7D camera and MPE 65 mm Macro lens, using a Visionary Digital Passport 2 Imaging system, and the multiple stacks composited using Helicon Focus software. Measurements were made using digital electronic calliper accurate to 0.01 mm. The map was produced using the facility in the Atlas of Living Australia (<http://www.ala.org.au/>).

*Abbreviations for collections.* AM – Australian Museum, Sydney; ANIC – Australian National Insect Collection, Canberra; IRSB – Institut Royal des Sciences Naturelles de Belgique, Brussels; MNHN – Muséum National d'Histoire Naturelle, Paris; MMUS – Macleay Museum, University of Sydney; MV – Museum of Victoria, Melbourne; PMH – Paul Hutchinson collection, Perth; QDAF – Queensland Department of Agriculture and Fisheries, Brisbane; QM – Queensland Museum, Brisbane; SAM – South Australian Museum, Adelaide; UQIC – University of Queensland Insect Collection (housed at QM); WAM – Western Australian Museum, Perth.

### Systematics

Family Scarabaeidae Latreille, 1802  
Subfamily Dynastinae Macleay, 1819  
Tribe Pentodontini Mulsant, 1842  
Subtribe Pseudoryctina Carne, 1957

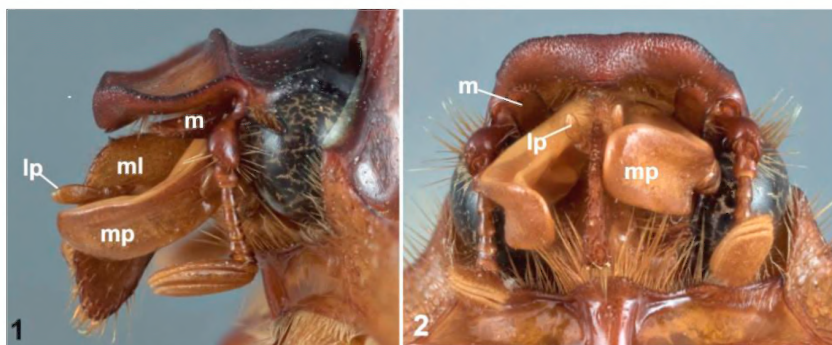
#### ***Neprodopus* Sharp, 1873**

*Type species.* *Neprodopus enigma* Sharp, 1873 (by monotypy).

*Diagnosis. Male.* Dark reddish brown, black or bicolorous black and yellow-brown. Mouthparts highly modified (Figs 1-2, 27-28); mentum and ligula compressed to form a thin vertical lamina divided by the ligular suture; labrum small, not produced beyond clypeus; mandibles incapable of



apposition, exposed beyond clypeus; terminal segment of maxillary palps with last segment usually greatly enlarged; galeae reduced to small pieces, not toothed. Clypeus at angle to plane of frons, transverse, produced in middle of anterior margin. Frons glabrous. Antennae 8-, 9- or 10-segmented; clubs enlarged but shorter than shaft. Pronotum with anterior horn and a pair of lateral horns or strong tubercles with a strong glabrous excavation between them and extending to posterior margin, or with medial third adjacent to anterior margin bearing a transverse 3-dentate horn, followed by a deep setose depression to base, laterally with an obtuse swelling; anterior margin membranous on either side of median horn; sides strongly rounded. Scutellum large. Elytra narrowing posteriorly, each with or without a distinct tubercle near scutellum; epipleurae with setae extending to apices. Pygidium setose across base; apical ridge broadened, divided and setose. Postcoxal process of prosternum conspicuous. Fore tibiae tridentate, basal tooth small, spur very long. Hind legs stout; femora with single sulcus; tibia with distal margin ciliate. Claws simple.



**Figs 1-2.** Mouthparts of male *Nephrodopus enigma* Sharp: (1) lateral; (2) frontal. lp, labial palp; m, mandible; ml, combined mentum and ligula; mp, maxillary palp.

*Female* (only *N. enigma* known: Figs 20-23). Mandibular palpi with apical segment not enlarged. Mandibles narrow and concealed. Antennae 9-segmented; club shorter than males. Pronotum very convex and without armature. Elytra without armature. Otherwise like males.

*Comments.* Adults of most species of the Australian Pseudoryctina appear not to feed as in many species the mouthparts are scarcely functional (Carne 1957). This is consistent with the apparent short, active life of the adults. The highly modified mouthparts with their enlarged maxillary palps, the vertical development of the mentum and the narrow mandibles that do not meet clearly suggest that both species of *Nephrodopus* do not feed. Why then have the mouthparts developed to such a bizarre extreme? Conventional thought suggests that a character will only persist if there is a functional use. However, if a mutation gives rise to a character that does not hinder an

individual's fitness, then that character can persist. In *Nephrodopus*, we hypothesise that non-feeding as adults preceded the extreme development of the mouthparts – thus, fitness was not compromised.

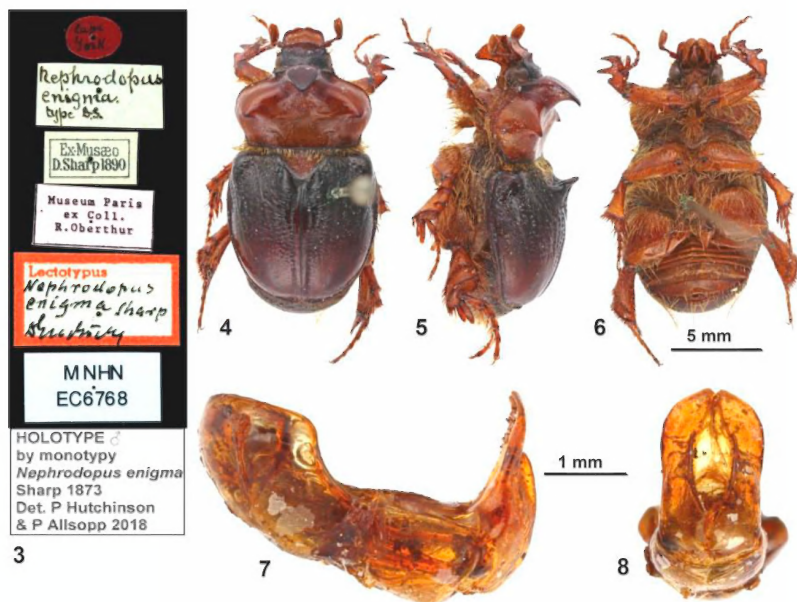
### *Nephrodopus enigma* Sharp, 1873

(Figs 1-23)

*Nephrodopus enigma* Sharp, 1873: 269; Sharp 1875: 47; Carne 1957: 151, Figs 525-536, Map 19; Endrődi 1974: 18, 21, 32, Fig. 17; Endrődi 1985: 369, Fig. 1364; Dechambre 2005: 55-56 (includes unnumbered figures and map).

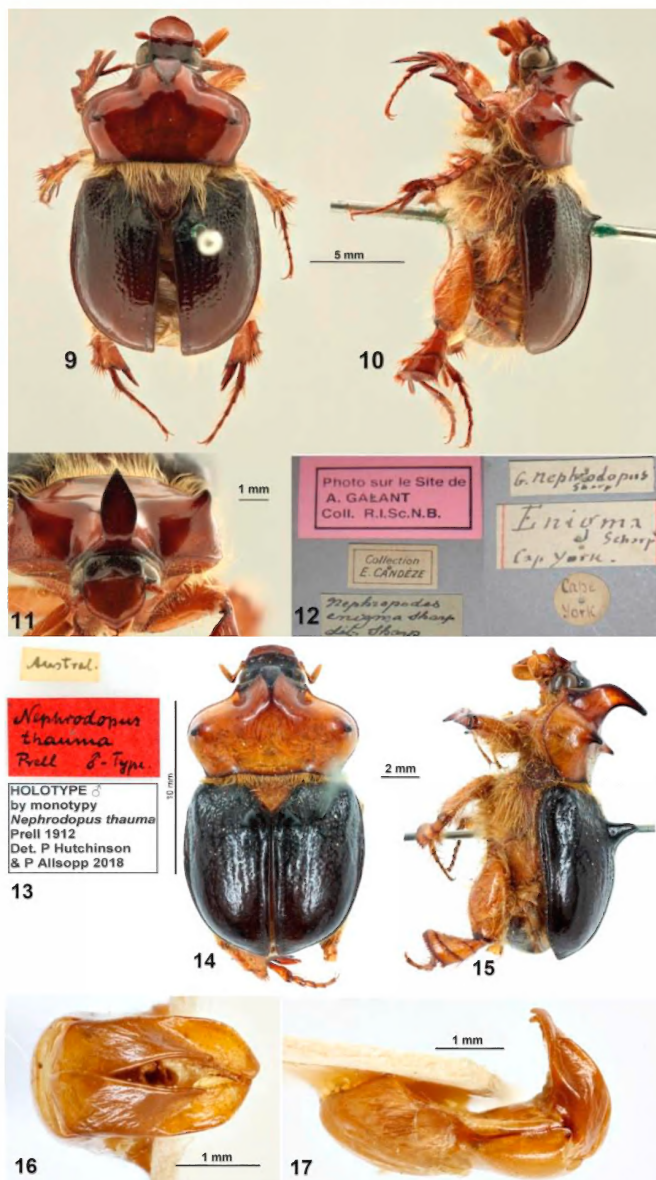
*Nephrodopus thauma* Prell, 1912: 105; Carne 1957: 151 (syn.).

*Nephrodopus enigma* var. *niger* Lea, 1917: 575, plate 34, Figs, 32-33; Carne 1957: 151 (syn.).



**Figs 3-8.** Holotype male of *Nephrodopus enigma* Sharp in MNHN: (3) labels; (4) dorsal, (5) lateral and (6) ventral views; (7) aedeagus lateral and (8) aedeagus frontal views (collage of photographs © MNHN/A. Mantilleri with holotype label added).

**Type material.** *Nephrodopus enigma*: Holotype ♂ by monotypy, Cape York, in MNHN (Figs 3-8). Sharp (1873) described *enigma* from only one male specimen 'Je ne connais qu'un seul exemplaire ♂' and he noted that the female was unknown. He reinforced this in his second paper (Sharp 1875), where he said 'Depuis ma description du genre *Nephrodopus*, j'ai obtenu un second exemplaire de *N. enigma* ...'. A specimen in MNHN (Figs 4-6) bears Sharp's type label (Fig. 3) – it was designated lectotype by Endrődi (1974), an unnecessary designation that was followed by Cassis and Weir (1992).



**Figs 9-17.** *Nephrodopus enigma* Sharp: (9-12) male in IRSB: (9) dorsal, (10) lateral and (11) frontal views (collage of photographs by Camille Locatelli, © IRSB); (12) labels. (13-17) holotype male of *Nephrodopus thauma* Prell in ZMB: (13) labels; (14) dorsal and (15) lateral views; (16) aedeagus frontal and (17) aedeagus lateral views (collage of photographs © ZMB with holotype label added).



There is a second specimen in IRSB labelled as ‘Type’ (Figs 9-12). It has the mouthparts partly dissected (Fig. 11) and is probably the specimen seen by Sharp (1875) and used in his description of the mouthparts. It was not labelled by Sharp as a type but simply as ‘det. Sharp’. We presume that the type label and the label with ‘Sharp’ [*sic*] were added by a later curator. The ‘Type’ label has been removed (A. Drumont pers. comm. 2018).

*Nephrodopus thauma*: Holotype ♂ by monotypy, Australien (ohne nähere Angabe), in ZMB (Figs 13-17). Prell (1912) described this species from only one male specimen ‘♀ unbekannt. Vorliegendes Material: 1 ♂’.

*Nephrodopus enigma* var. *niger*: Lectotype ♂ here designated, Alligator River, N.T., in SAM (Fig. 18). Lea (1917) saw more than one male ‘Some males from the Alligator River ...’ and Carne (1957) and Cassis and Weir (1992) referred to an unknown number of syntypes. There are two dark males in SAM (P. Hudson pers. comm.) and four dark males in MV (K. Walker pers. comm.) (Fig. 19), all from Alligator River. The one in SAM labelled ‘*enigma* var. *niger*’ (Fig. 18) we hereby designate as the lectotype to ensure stability of nomenclature and have labelled it as such; the other five we regard as paralectotypes. Northwestern Arnhem Land has the East Alligator River, the South Alligator River and the West Alligator River (12-13°S, 132-133°E) flowing into Van Diemen Gulf – we do not know which of these is the type locality.



**Figs 18-19.** Black form of *Nephrodopus enigma*: (18) labels of lectotype male of *Nephrodopus enigma niger* Lea in SAM (photograph by Peter Hudson, © South Australian Museum Board 2018 with lectotype label added); (19) male, lateral and label (collage of photographs by Ken Walker, © MV).

*Additional material examined.* AUSTRALIA: QUEENSLAND: 1 ♂, Cairns (ANIC on loan from MMUS); 3 ♂♂, Cairns district, J.A. Anderson (QDAF, QM); 1 ♂, Cape York (ANIC on loan from MMUS); 2 ♂♂, 4 km SW Casuarina Hill, 15.03S, 145.15E, 30.iv-2.v.1981, I.D. Naumann, A. Calder (ANIC); 1 ♂, Cockatoo Creek, 11.39S 142.27E, 2.iii-5.iv.1993, P. Zborowski, flight intercept trap (ANIC); 1 ♂,



Cockatoo Creek, 20.iv-20.v.1994, P. Zborowski, flight intercept trap (ANIC); 1 ♂, Cockatoo Creek Xing, 17 km NW Heathlands, 22.iii-25.iv.1992, T. McLeod, flight intercept trap open forest (ANIC); 2 ♂♂, Gum Gum, 14.ii.1956, 18.ii.1956, Wassell (UQIC); 1 ♂, Hann River, 15.11S 143.52E, 17.xii.1993, P. Zborowski, at light (ANIC); 6 ♂♂, 5 km SE Hann R. bridge, 15.13S 143.55E, 15.i.1994, P. Zborowski, E.D. Edwards, at light (ANIC); 3 ♂♂, Heathlands, Cape York Pen., 11.45S, 142.34E, 17.iii.1992, G. Daniels, M.A. Schneider (UQIC); 1 ♂, 9 km WNW Heathlands, 11.42S 142.30E, 21.iii.1994, P. Zborowski, at light (ANIC); 5 ♂♂, Hibbard Point, Weipa, 5-8.ii.1975, G.B. Monteith, coll. at MV Light (UQIC); 19 ♂♂, 1 ♀, 13 km W Musgrave, Qld, 14°48'S, 143°23'E, 15.i.1994, 220 m, G. & A. Daniels, R. Eastwood, mv lamp // PMH coll. # Dyn 1209, 1296 (AM, PMH, UQIC); 1 ♂, Musgrave, 20.ii.1988, G. Wood (QDAF); 2 ♂♂, Prince of Wales Island, Gulf of Carpentaria, ii.1939, R.G. Wind (ANIC); 3 ♂♂, Sweers Island (ANIC on loan from MMUS). NORTHERN TERRITORY: 1 ♂, Elcho Island, v.1977, Carnaby (ANIC); 2 ♂♂, Nourlangie Creek, 8 km E Mt Cahill, 12.52S 132.47E, 6.xii.1977, C.R. Dunlop (ANIC). NO LOCALITY: 1 ♂ (ANIC).



**Figs 20-23.** Female of *Nephrodopus enigma* Sharp: (20) dorsal; (21) lateral; (22) mouthparts lateral; (23) mouthparts frontal.

*Description of female* (Figs 20-23). Length 15.5 mm, pronotal width at widest point 7.5 mm; elytral width 9.2 mm. Yellow, elytral base, apical segment of mandibular palpi, foretibia, marginal edges of head, pronotum, elytra, ventral surface and legs light brown. Mentum and ligula highly compressed forming rectangular lamina (lacking ventral process) (Fig. 22), very long setae on margins, faces bearing sparse setae; labial palpi short; apical segment of maxillary palp not enlarged, conical (Fig. 23). Labrum concealed at edge of clypeus. Mandibles narrow and concealed. Clypeus transverse hemispherical, slightly produced anteriorly, margins slightly raised, anterior margin shallow, impunctate and glabrous, remaining surface sparsely punctate, glabrous; clypeofrontal ridge linear, declivous to frons.

Frons slightly depressed anteriorly, surface sparsely punctate, glabrous. Ocular canthi broad, stout, setose, at obtuse angle to clypeus. Antenna 9-segmented, club shorter than shaft (subequal to segments 3-6 in length), setose on all 3 segments, scape and pedicel.

Pronotum widest at midlength, very convex and lacking armature, anterolateral angles slightly produced and obtuse, posterolateral angles slightly obtuse; marginal ridge fine but obsolete across median third of base; surface micropunctate, glabrous. Scutellum large, transverse, rugulose, setose. Elytral armature absent; sutural stria punctate in anterior half, linear punctate posteriorly, surface with striae distinct, punctures not discernible, few setae at base beside scutellum. Prosternal process short, tapering, setose. Foretibia tridentate, apical two very long and acute, spur elongated, protarsomere 1 twice length of 5, claws very small. Metafemora stout; metatibia stout, bicarinate, spurs slightly arcuate; metatarsomere 1 bilaterally expanded, about 2.5 times length of 5, tarsomeres 1-5 short (subequal to tibial length).

Sternites setose across posterior margins; pygidium transverse, weakly convex, apical ridge with median third bearing long setae, surface setose across base, disc sparsely and finely punctate.

*Comments.* There is considerable variation in this species in size (presumably reflecting different larval nutrition) and the development of the pronotal and elytral armature, colour and the number of antennal segments. Carne (1957) noted this and described four variations: the 'typical enigma' form; the black 'niger' form; the 'extreme variant' form; and the 'intermediate' form.

Males in PMH (# Dyn 1209), AM, ANIC, QM and UQIC from northern Queensland conform to the 'typical enigma' form with enlarged maxillary palps, the antennal club shorter than the shaft and male genitalia as in Figs 16-17. The head and elytra of the typical form are usually nearly black, contrasting with the yellow-brown pronotum and legs (Figs 4-5, 9-10, 14-15) but there are specimens with only the anterior of the elytra black and some with the pronotum very dark brown.

The black form (Fig. 19) is identical except for its colour. This variation occurs in specimens from the same locality (Cockatoo Creek), albeit collected at different times in different years. We suggest that the colour variation might simply be differences among individuals that have eclosed but waited for different times for rain to emerge; the black form waiting longer than the bicoloured forms, thus allowing full melanisation. Specimens are known from northern Queensland and the Northern Territory.

The extreme variant form has maxillary palps much less enlarged and the antennal club longer than the two previous forms, with slight differences in the male parameres (Carne 1957); it is known from Bowen and Sweers Island in Queensland.

The intermediate form, from Groote Eylandt, Northern Territory, has enlarged maxillary palps but these are more crescent-shaped than in the typical specimens and the antennal club is longer as in the extreme form.

Like Carne (1957), we retain all of these forms within the same species. The antennal club can be of 8-10 segments (usually 9) but these are sometimes poorly defined, making it difficult to determine exactly how many there are.

As with other scarabs, the origin of such structural variation is difficult to establish (Gasca-Álvarez *et al.* 2018, Kizub and Leshchenko 2019 and references in both). Abnormalities can be caused by the action of endogenous or exogenous factors that influence embryonic and/or postembryonic development and viral infections or parasites can also be associated with the occurrence of malformations. Some malformations can be coded in the DNA and are transferable to subsequent generations. In some cases, malformations can be produced by the effects of a single gene (*e.g.* Ohde *et al.* 2018), or are characterised by diverse phenotypic expressions that might involve multiple genes and their interactions with the environment.

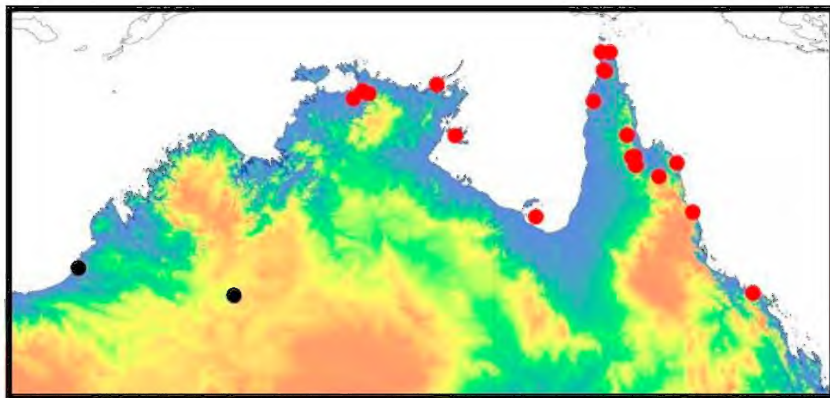
Ohde *et al.* (2018) showed that three genes function in the formation of both the male and female clypeolabral region and in the male head horn of the dynastine *Trypoxylus dichotomus* (Linnaeus, 1771), while changes in the expression level of these genes alter horn shape and size and alter clypeolabral structure. Non-expression of five other genes also altered the number of antennal segments and leg structures. Given its unusual mouthparts structure, similar processes might be occurring in the different forms of *N. enigma* – DNA data might provide a better explanation of the variation in this species.

Females lack pronotal and elytral armature, the enlarged antennal club and the enlarged apical segment of maxillary palps (Figs 20-23).

*Differential diagnosis.* Males have a pronotum with a triangular and reflexed anteromedial horn and a pair of lateral horns, the pronotal surface glabrous and each elytron with a conical spine near the scutellum, which distinguishes them from males of the species described below.

*Distribution, habitat and behaviour.* This species is known from the dry tropics across northeastern Queensland and northern Northern Territory (Fig. 24). We have not been able to determine where Gum Gum is but suspect that it is near Silver Plains (13.98°S, 143.55°E), where Wassell lived during 1952-1965 (Marks 1968).

Specimens from near Musgrave, Queensland, were taken in an area of sandy soil at light in mid-January – it had been very dry prior to that time but it rained heavily early that night with much fauna then being active (G. Daniels pers. comm. 2018). Specimens from other localities have been collected from December through to May, in flight intercept traps or taken at light.



**Fig. 24.** Distribution of *Nephrodopus enigma* (red dots) and *N. goldingi* sp. n. (black dots) across northern Australia; background colours show elevation. Data taken from specimens we examined, photographs of specimens seen by us and specimens recorded by Carne (1957).

***Nephrodopus goldingi* sp. n.**

(Figs 25-32)

*Type material. Holotype* ♂: WESTERN AUSTRALIA: Balgo Hills [now Balgo], W.A., M. Golding/ 31.10.[19]85 // Golding/Powell collection donated 12 Feb 2002 (WAM). *Paratypes*: 1 ♂, same data as holotype, except no collection date (WAM); 1 ♂, Nita Downs Station, 19°05'S 121°41'E, Western Australia, January 1981, A.M. & M.J. Douglas // mostly from swimming pool or vicinity of homestead light ex alcohol (WAM); 1 ♂, Balgo Hills, 17.12.[1985], M. Golding (ANIC).

*Description of holotype male* (Figs 25-30). Condition: left protarsomeres 2-5 and left metatarsomeres 4-5 missing. Length 14.1 mm; pronotal width 6.7 mm; elytral width 7.9 mm. Head and elytra chestnut brown, remainder light brown with darker margins. Mentum with short stout setae on lateral, ventral and apical margins and on lateral faces; labial palp 3-segmented, apical segment elongate; labrum concealed; maxillary palp with apical segment rectangular, greatly enlarged. Clypeus transverse triangular, margins weakly raised, surface densely and finely punctate; clypeofrontal ridge transverse and declivous to frons. Frons angulate to clypeus, evenly convex, coarsely punctate, glabrous, posteriorly impunctate. Ocular canthi narrow, obtuse to clypeus. Antenna with club equal to shaft, 9- segmented.

Pronotum, medial third adjacent to anterior margin bearing a transverse 3-dentate horn, followed by a deep depression to base, laterally with an obtuse swelling; surface punctate-setose over whole surface except anterior to lateral swellings. Anterolateral angles not produced, very obtuse, widest at anterior third, lateral ridge along basolateral third, basal ridge sublinear; sides divergent and highly convergent to anterolateral angles. Scutellum with short setae across basal declivity.





**Figs 25-30.** *Nephrodopus goldingi* sp. n., holotype male: (25) dorsal; (26), lateral; (27) head showing mouthparts lateral; (28) head showing mouthparts frontal; (29) aedeagus frontal; (30) aedeagus lateral.

Elytra attenuate/gradually narrowing from base to narrow apex; with sutural stria, disc with punctate stria in geminate rows; calli low, indistinct; epipleural setae continuous to apex and longest in apical half.

Foretibia tridentate, spur long and narrow, tarsomere 1 longer than 5, claws small and simple; metafemur highly convex, tibia stout, bicarinate, spurs broad, metatarsomere 1 bilaterally expanded and longer than 5.

Ventral abdomen densely clothed with long pale setae; prosternal process densely pilose; sternites short/compact, bearing a row of long setae along posterior margins. Pygidium transverse, bearing very long setae except near apex; apical ridge setose. Propygidium lacking stridulation bands. Genitalia with parameres symmetrical (Figs 29-30).

*Female.* Unknown.

*Variation.* Specimen length 13.1-15.3 mm; elytral width 7.1-7.9 mm. The Nita Downs specimen (Figs 31-32) is black, nitid and with the antennae diluted brown. The mentum is without setae and the clypeus is hemispherical. This is similar to the variation we have seen in *N. enigma*.



**Figs 31-32.** *Nephrodopos goldingi* sp. n., black form: (31) dorsal; (32) lateral.

*Differential diagnosis.* Males have 9-segmented antennae, a pronotum with a nearly vertical, anterior, transverse horn bearing three denticles, followed by a setose depression and elytra without conical spines near the scutellum, which distinguishes them from males of *N. enigma*.

*Etymology.* This species is named for Mark Golding, who captured three specimens while living at Balgo, Western Australia. Mark is an avid aficionado of Australian Coleoptera and has donated many specimens from remote locations.

*Distribution, habitat and behaviour.* Balgo (20.14°S, 127.98°E) is on the eastern edge of the Great Sandy Desert and Nita Downs Station (19.09°S, 122.68°E) is on the western edge (Fig. 24). Both localities have an annual average rainfall of 250-500 mm and the habitats are predominately shrubby grassland over sandy soil. Known specimens were collected in late October and January and most likely emerged in response to rainfall associated with the onset of the northern wet season.

### Key to males of *Nephrodopus*

Pronotum with anteromedial horn triangular and reflexed, pair of lateral horns, pronotal surface glabrous, each elytron with a conical spine near the scutellum (Figs 1-19); northern Northern Territory and northern Queensland ..... *N. enigma* Sharp, 1873

Pronotum with anteromedial horn transversely tridentate, pronotal surface setose in and around concavity, elytral spines absent (Figs 25-32); northwestern Western Australia ..... *N. goldingi* sp. n.

### Acknowledgements

We thank Nic Tatarnic and Brian Hanich (WAM) for access to collections and use of equipment, Paige Maroni for demonstrating the use of the photostacking camera at WAM, Thekla Pleines and Cate Lemman (ANIC), Peter Hudson (SAM), Ken Walker (MV), Derek Smith (AM), Antoine Mantilleri (MNH) and Alain Drumont and Camille Locatelli (IRSB) for access to, information on and photographs of specimens in their care. Tom Weir and Geoff Monteith provided much appreciated comments that helped us refine the manuscript.

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**NEW AUSTRALIAN RECORDS OF *CEPHRENES AUGIADES*  
*BRUNO* EVANS, 1935 (LEPIDOPTERA: HESPERIIDAE) AND  
*HYPOLIMNAS BOLINA NERINA* (FABRICIUS, 1775) FEMALE  
FORM *PALLESCENS* POULTON, 1924 (LEPIDOPTERA:  
NYMPHALIDAE) FROM DAUAN ISLAND, TORRES STRAIT,  
QUEENSLAND**

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### **Abstract**

The first records of *Cephrenes augiades bruno* Evans, 1935 and female form *pallescens* Poulton, 1924 of *Hypolimnas bolina nerina* (Fabricius, 1775) are reported from Dauan Island, northern Torres Strait, Queensland. Both sexes of *C. a. bruno* are compared with specimens of *C. augiades* (C. Felder, 1860) from mainland Papua New Guinea, Thursday Island, Horn Island and Iron Range (Cape York Peninsula). The flight behaviour of *H. b. nerina* form *pallescens* is discussed.

### **Introduction**

Three species of the genus *Cephrenes* Waterhouse & Lyell, 1914 occur within Australia: *Cephrenes moseleyi* (Butler, 1884) is restricted to Dauan and Saibai Islands, northern Torres Strait (Lambkin and Knight 2004, Braby 2016), while *C. augiades* (C. Felder, 1860) and *C. trichopepla* (Lower, 1908) have an irregular distribution across Australia (Braby 2000), with the latter two species spreading widely across Australia by accidental introduction with their host plants (Braby 2016). *Cephrenes augiades sperthias* (C. Felder, 1862) is restricted to the Australian mainland and the southern Torres Strait islands south from Moa (Braby 2000). Three additional subspecies of *C. augiades* are recognised from Papua New Guinea (PNG), namely *C. a. bruno* Evans, 1935, *C. a. meeki* Evans, 1935 and *C. a. websteri* Evans, 1935. *Cephrenes a. bruno* is widespread throughout mainland PNG, including Western Province, which borders the northern Torres Strait.

Between 2001 and 2018, one male and four females of *C. augiades* were collected on Dauan Island, which lies very close to the southern coastline of PNG. They were compared with specimens of *C. a. sperthias* from southern Torres Strait and Cape York Peninsula and a female of *C. a. bruno* from the Maprik area of PNG and were found to match *C. a. bruno*.

*Hypolimnas bolina nerina* (Fabricius, 1775) is sexually dimorphic, exhibiting striking female-limited genetic colour polymorphism (Lachlan 2014). Poulton (1924) recognised four main female forms: *euploeoides* Poulton, *nerisa* Poulton, *nerina* and *pallescens* Poulton. The form name '*pallescens*' has been used to describe some of the many different forms of the extremely polymorphic *H. bolina* (Linnaeus, 1758) females found on many of the Pacific Islands and in other parts of its known range (Lachlan 2014, 2015a, 2015b).

On the trip to Dauan Island in May 2018, a strikingly marked female form of *H. b. nerina* was collected. Comparison of the specimen with those illustrated by Lachlan (2014, 2015a, 2015b) showed it to be a typical example of form *pallescens*, which was previously unrecorded from Australia.

The following abbreviations refer to repositories from which material has been examined: ANIC – Australian National Insect Collection, Canberra; CEMC – C.E. Meyer Collection, Brisbane; SJJ – S.J. Johnson Collection located in the Museum of Tropical Queensland, Townsville; SSBC – S.S. Brown Collection, Bowral; TLIKC – joint collection of T.A. Lambkin and A.I. Knight, Brisbane. Abbreviations of collectors' names are: AIK – A.I. Knight; AJJ – A.J. Johnson; CEM – C.E. Meyer; IRJ – I.R. Johnson; PRW – P.R. Wilson; SJJ – S.J. Johnson; SSB – S.S. Brown; TAL – T.A. Lambkin.

### ***Cephrenes augiades bruno* Evans, 1935**

(Figs 1-12)

#### *Material examined*

#### *Cephrenes augiades bruno*

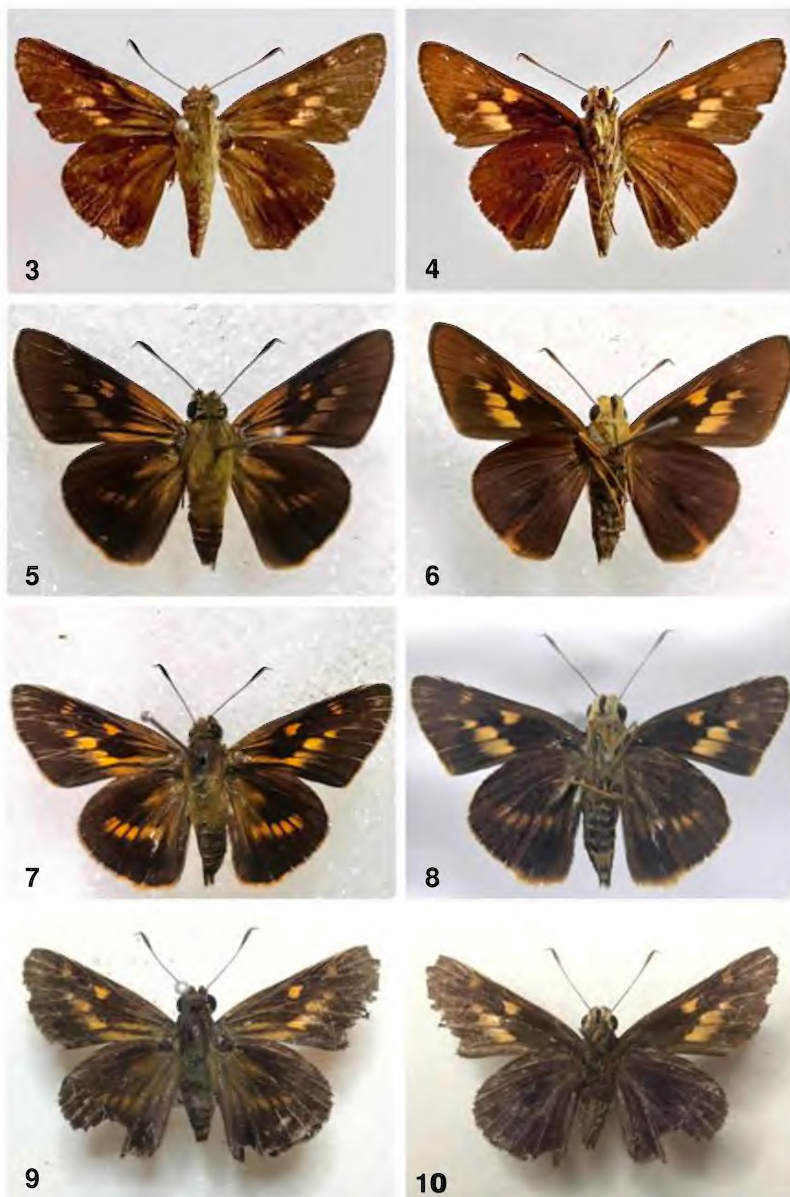
QUEENSLAND: 1 ♀, Dauan Island, Torres Strait, 13-19.iv.2001, SSB and CEM (SSBC); 1 ♀, Dauan Island, Torres Strait, em 18.iv.2004, SJJ (SJJ); 1 ♀ Dauan Island, Torres Strait, 3-10.iii.2016, IRJ and PRW (SJJ); 1 ♀, Dauan Island, Torres Strait, 14-21.v.2018, IRJ (SJJ); 1 ♂, Dauan Island, Torres Strait, 14-21.v.2018, IRJ (SJJ). PAPUA NEW GUINEA: 1 ♀, New Guinea, Maprik (Sepik District), 600 ft, 20.vi.1950, collected by William Brandt and E.J.L. Hallstrom (ANIC).

#### *Cephrenes augiades sperthias*

QUEENSLAND: 1 ♂, Green Hill, Thursday Island, Torres Strait, 7-9.iv.2000, CEM (CEMC); 1 ♂, Horn Island, Torres Strait, 18.v.2012 TAL and AIK (TLIKC); 1 ♂, Iron Range, Cape York Pen, 5-11.xii.1995, SJJ (SJJ); 1 ♀, Iron Range, Cape York Pen, 5-20.viii.1983, AJJ (SJJ).



**Figs 1-2.** *Cephrenes augiades bruno* male from Dauan Island, Torres Strait (14-21.v.2018, IRJ): (1) upperside; (2) underside.



**Figs 3-10.** *Cephrenes augiades bruno* females from Dauan Island, Torres Strait: (3) upperside (13-19.iv.2001, SSB and CEM); (4) underside; (5) upperside (18.iv.2004, SJJ); (6), underside; (7) upperside (3-10.iii.2016, IRJ and PRW); (8) underside; (9) upperside (14-21.v.2018, IRJ); (10) underside.

*Description of C. a. bruno*

Wingspan; male 37 mm; female 44 mm. Upperside male (Fig. 1) dark brown-black with orange markings; forewing with a distinct elongated patch in cell, a streak along costa, two or three indistinct subapical spots, a postmedial band of three spots between veins  $M_3$  and  $1A+2A$ , subterminal spots between veins  $M_1$  and  $M_3$  absent, two streaks along dorsum above and below vein  $1A+2A$ ; hind wing with an obscure spot in discal cell and a narrow postmedial band of spots generally becoming smaller towards the termen. Underside (Fig. 2) orange-brown with marking similar to the upperside except hind wing cell spot and postmedian band of spots obscure or absent and a distinct brown-black tornal patch edged with yellow-brown. Upperside female (Figs 3, 5, 7, 9) dark brown-black tinged with dark purple and with orange to orange-brown markings; forewing with an indistinct to small patch in cell, an orange-brown streak along lower costa, 2-3 indistinct subapical spots that can be absent, a postmedian band of three spots that can be indistinct between veins  $M_3$  and  $1A+2A$ , subterminal spots between veins  $M_1$  and  $M_3$  absent, two indistinct streaks along dorsum above and below vein  $1A+2A$ ; hind wing with an obscure spot in cell and a narrow postmedial band of distinct to obscure spots. Underside (Figs 4, 6, 8, 10) orange-brown with yellower marking similar to the upperside except hind wing cell spot absent and postmedian band of spots obscure, tornal patch obscure or absent.



**Figs 11-12.** *Cephrenes augiades bruno* female from Maprik (Sepik District), Papua New Guinea: (11) upperside (20.vi.1950, William Brandt and E. J. L. Hallstrom); (12) underside.

*Discussion*

Geographically, the closest records of *C. augiades* in Australia are from Thursday and Horn Islands (approximately 133 km south of Dauan in southern Torres Strait) (Figs 13-14, 19-20) and Iron Range in northern Cape York Peninsula on the Australian mainland (Figs 15-18). Dauan Island lies just 11 km south of the PNG coastline. Examination of the female collected in 2004 (Figs 5-6), together with the subsequently collected male in 2018 (Figs 1-2) and other females (Figs 3-4, 7-10), helped confirm the original suspicion that it might be *C. a. bruno*. The Dauan Island females (Figs 3-10)





**Figs 13-20.** *Cephrenes augiades sperthias* from Thursdays and Horn Islands, Torres Strait and Iron Range, Cape York Peninsula: (13) male, upperside, Thursdays Island (7-9.iv.2000, CEM); (14) male, underside; (15) male, upperside, Iron Range (5-11.xii.1995, SJJ); (16) male, underside; (17) female, upperside, Iron Range (5-20.viii.1983, AJJ); (18) female, underside; (19) male upperside, Horn Island (18.v.2012, TAL and AIK); (20) male, underside.

all have the dark purple suffusion at the base of the hind wing and the apex of the forewing underside and markings that are consistent with those described by Evans (1949) and Parsons (1998) and the PNG specimen in the ANIC (Figs 11-12), including the lack of subterminal spots between veins  $M_1$  and  $M_3$  on the forewing. The male specimen differs from *C. a. sperthias* by having the dark purple suffusion at the base of the hind wing, the thinner, differently shaped forewing orange band, the generally reduced orange forewing and hind wing markings, the lack of forewing subterminal spots between veins  $M_1$  and  $M_3$  and the darker orange-brown base colour of the underside.

Despite the acknowledged variability of this species, the specimens from Dauan Island were consistent in their appearance with *C. a. bruno*, which is widespread throughout the PNG mainland (Parsons 1998). Collection of specimens from intervening islands would provide further information on the distribution of the two subspecies. Interestingly, *C. augiades* is currently unknown from most of Torres Strait apart from Dauan, Thursday and Horn Islands.

***Hypolimnast bolina nerina* (Fabricius, 1775)**

**form *pallascens* Poulton, 1924**

(Figs 21-22)

*Material examined*

QUEENSLAND: 1 ♀, Dauan Island, Torres Strait, 14-21.v.2018, IRJ (SJJC).

*Description*

Form '*pallascens*' differs from other female forms in having a dark brown ground colour with a row of white spots suffused with brown bordering the distal edge of both fore- and hind wings. The forewing has a subapical white band of four spots and the hind wing has a large white patch centrally; the basal areas of both fore- and hind wings are dark brown with the distal areas orange-brown.

*Discussion*

Apart from its distinctive coloration (Figs 21-22), the flight pattern of the specimen collected was markedly different from that of *H. bolina* females of the usual form, with which it flew on Dauan Island. The specimen flew quite rapidly and rarely alighted, its flight being more erratic than that of the other, darker forms. This abnormal behaviour was also noted by Lachlan (2015b) when discussing form '*pallascens*' in Tonga.

**Acknowledgements**

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**Figs 21-22.** *Hypolimnastis bolina nerina* female form *pallascens* from Dauan Island, Torres Strait: (21) upperside; (22) underside.

the Brandt Collection (ANIC), Robyn Cumming for photographs of specimens in the Museum of Tropical Queensland (SJJC) and T.A. Lambkin, S.S. Brown and C.E Meyer for specimen data and photographs of their Torres Strait material. In addition, C.G. Miller and R.P. Weir provided specimen data from their collections.

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# RANGE EXTENSION FOR *ANTHENE SELTUTTUS* (RÖBER, 1886) (LEPIDOPTERA: LYCAENIDAE) IN NORTHEASTERN AUSTRALIA

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## Abstract

The lycaenid butterfly *Anthene seltuttus affinis* (Waterhouse & R.E. Turner, 1905) is newly recorded breeding at Gladstone, Qld, extending the southern geographical (latitudinal) range of the species by approximately 90 km SE of Rockhampton. Larvae were recorded feeding on the foliage of *Cupaniopsis anacardioides* (A. Rich.) Radlk. (Sapindaceae) and attended by *Oecophylla smaragdina* (Fabricius) ants. The range extension adds to the growing list of butterfly species in eastern Australia that have expanded their range considerably further southwards into new areas in recent decades.

The lycaenid butterfly *Anthene seltuttus* (Röber, 1886) ranges from Maluku through mainland New Guinea and its adjacent islands to northern and northeastern Australia and the Louisiade Archipelago. In Australia it is represented by the subspecies *A. seltuttus affinis* (Waterhouse & R.E. Turner, 1905), which in northeastern Queensland occurs from the Torres Strait islands (Moa Island) to Yeppoon and Rockhampton (Common and Waterhouse 1981, Braby 2000). The species occurs mainly in lowland rainforest and monsoon forest but it is also common in suburban areas where the food plants are cultivated and colonies of the attendant ant are established. The larvae in Australia feed on a wide range of food plants, including the families Fabaceae, Lauraceae, Malvaceae, Myrtaceae and Sapindaceae (Braby 2000).

On 22 March 2017, approximately a dozen mid-instar larvae of *Anthene seltuttus affinis* (Fig. 1) were recorded feeding on new, soft leaf growth of *Cupaniopsis anacardioides* (A. Rich.) Radlk. (Sapindaceae) at Gladstone, Qld (23.8337°S, 151.2474°E). The food plant grew as an ornamental tree at the Information Centre near the marina. The larvae were attended by numerous *Oecophylla smaragdina* (Fabricius) ants, which had established arboreal nests in the tree.

This new locality extends the geographical range of the butterfly by approximately 90 km SE of Rockhampton and defines the southern limit of the species. Interestingly, almost 30 years ago Hacobian (1992) reported the attendant ant, *O. smaragdina*, from the Gladstone district – at Canoe Point Reserve at Tannum Sands, 20 km SE of Gladstone, as well as near the Rundle Range – in late 1991-early 1992. He also recorded three other lycaenid butterflies obligatorily associated with this ant near Gladstone,



namely *Hypolycaena phorbas* (Fabricius, 1793), *Arhopala eupolis* (Miskin, 1890) and *Arhopala micale* Blanchard, 1848, but not *Anthene seltuttus*, which is obligatorily attended by the same ant. The immature stages of both *H. phorbas* and *Arhopala eupolis* were recorded on *Cupaniopsis* sp. (Hacobian 1992). The Gladstone district defines the southern latitudinal limit of the ant and the four lycaenid butterflies noted above that are associated with it. It remains to be determined if *Anthene seltuttus* is permanently established in the Gladstone district, or persists on a temporary basis with the population temporarily re-colonising the region from source populations further north.



**Fig. 1.** Larva of *Anthene seltuttus affinis* on *Cupaniopsis anacardioides* and attended by *Oecophylla smaragdina* at Gladstone, Qld. Photo: Y-F. Hsu.

In the past two decades, a number of butterflies along the eastern seaboard of the Australian mainland and Tasmania have been recorded from areas further south of their previous known ranges (e.g. Muller *et al.* 1998, Brown 2004, Mayo and Petrie 2004, Mayo 2004, 2015, Valentine 2004, Weir *et al.* 2005, Knight 2005, Faithfull 2008, Shakespeare *et al.* 2009, 2010, Moore 2009, 2010, Peters *et al.* 2010, Nielsen 2015, Franklin and Wood 2016, Matsui and Valentine 2016, Petrie and Moore 2017), but it is not always certain if these represent populations of species that were previously overlooked, recent natural range expansions into areas that were previously unoccupied, human-induced (non-natural) introductions, vagrants, temporary or permanent breeding populations. Perusal of the scientific literature suggests all of these

scenarios are applicable, with some species clearly expanding their range considerably further southwards and becoming permanently established in new areas (Samson and Lambkin 2003, Mayo 2004, Mayo and Petrie 2004, Valentine 2005, Sands 2007, Moss 2009, 2018, Moore 2010, Peters *et al.* 2010). Further analysis is required to determine if these latitudinal range shifts are correlated with increases in temperature as a result of global climate change, as predicted for butterflies in Australia (Beaumont and Hughes 2002, Hughes 2003) and elsewhere in the world (Parmesan *et al.* 1999, Parmesan 2006).

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# **CORRECTION TO THE NOMENCLATURE OF THE LARVAL FOOD PLANT FOR *HYPOCHRYSOPS CYANE* (WATERHOUSE & LYELL, 1914) (LEPIDOPTERA: LYCAENIDAE) IN SOUTHEASTERN QUEENSLAND**

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## **Abstract**

The correct botanical nomenclature for the larval food plant of *Hypochrysops cyane* (Waterhouse & Lyell, 1914) in the Millmerran-Leyburn district of southeastern Queensland, previously known under the name *Angophora costata* (Gaertn.) Britten, is *Angophora leiocarpa* (L.A.S. Johnson ex G.J. Leach) K.R. Thiele & Ladiges.

Larvae of the lycaenid butterfly *Hypochrysops cyane* (Waterhouse & Lyell, 1914) feed on several food plants, including the families Combretaceae, Fabaceae, Loranthaceae, Myrtaceae and Rhamnaceae (Braby 2000). In the Millmerran district in southeastern Queensland, the late Jack Macqueen recorded the larval food plant as *Angophora costata* (Gaertn.) Britten (Turner 1940, Macqueen 1965) from his property at Mount Emlyn, 18 km S of Millmerran. Prior to Macqueen's discovery of the species at Millmerran in 1929, *H. cyane* was considered to be very rare, known only from a few specimens from three locations (Waterhouse 1932, Turner 1940). On this host, it was noted that the immature (and adult) stages resided mainly in the canopy of large, mature trees (up to 20 m high) with extensive colonies of the ant *Anonychomyrma* sp. (*itinerans* group), which nest inside the trunk and hollowed branches of the tree (Turner 1940, Macqueen 1965, Sands 2018) and obligatorily attend the larvae of *H. cyane*, as well as those of *H. piceatus* Kerr, Macqueen & Sands, 1969 and *Ogyris aenone* (Waterhouse, 1902) (Macqueen 1965, Common and Waterhouse 1972, Eastwood and Fraser 1999). J. Macqueen reared adults of *H. cyane* from larvae and pupae collected inside hollowed branches of this plant species, some of which were blown down from the tops of the trees after storms, as well as from early instar larvae feeding openly on the foliage (see Turner 1940). Adults of *H. cyane* have also been recorded regularly at Leyburn perched in the canopy of the same *Angophora* species, on which they no doubt breed.

Since the early publications of Turner (1940) and Macqueen (1965), the larval food plant has undergone taxonomic revision. Leach (1986) described the subspecies *Angophora costata* subsp. *leiocarpa* L.A.S. Johnson ex G.J. Leach, based primarily on the fruit being smooth with the longitudinal ribs barely visible. However, this taxon was subsequently revised to full species status by Thiele and Ladiges (1988). Hence, the correct nomenclature for the



food plant is now *Angophora leiocarpa* (L.A.S. Johnson ex G.J. Leach) K.R. Thiele & Ladiges. This nomenclatural change was overlooked by Braby (2000, 2016) and in other publications on Australian butterflies (e.g. Orr and Kitching 2010). Distribution maps in Leach (1986), as well as the Atlas of Living Australia, show a clear geographical difference in the spatial distribution of the two plant species. *Angophora costata* primarily occurs along coastal New South Wales, whereas *A. leiocarpa* occurs widely in southeastern Queensland and northeastern New South Wales. *Angophora leiocarpa* extends well into inland areas, including the Millmerran-Leyburn district, where it grows on loose, well drained sandy soils on sandstone-capped hills or outcrops (Leach 1986).

Moss (2010) listed the food plant for *H. cyane* as '*Angophora leiocalyx*' but this botanical name is invalid because there is no species known by this scientific name.

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**FIRST RECORD OF *DELIAS HARPALYCE* (DONOVAN)  
(LEPIDOPTERA: PIERIDAE) IN SOUTH AUSTRALIA**

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**Abstract**

*Delias harpalyce* (Donovan, 1805) is recorded from South Australia for the first time. A male was observed and photographed at Bryton Wood near Mount Gambier in November 2017. The species is not known to breed in South Australia and the specimen most likely was a wind-assisted vagrant from western Victoria.

**Introduction**

*Delias harpalyce* (Donovan, 1805), commonly known as the Imperial Jezebel (Braby 2000) or Imperial White (Orr and Kitching 2010, Grund 2018), is endemic to Australia, where it occurs in cool temperate areas of the southeastern mainland (Braby 2000). The range of *D. harpalyce* is along the Great Dividing Range and adjacent ranges, from as far north as Warwick in Queensland, through New South Wales and the ACT to central and southern Victoria, extending as far west as the Little Desert and the western tip of the Otways and Grampians (Braby 2000, Orr and Kitching 2010, Field 2013). The flight period is all year round, with peaks in adult emergence in spring and late summer (Braby and Douglas 1992). *Delias harpalyce* disperses outside the regular breeding range, with adults occasionally recorded in inland areas of the Great Dividing Range (Braby 2000, Grund 2018). The breeding habitat comprises cool, damp, temperate forests, where larvae feed on mistletoes (Loranthaceae) growing on *Eucalyptus* or *Acacia* in eucalypt open forests and woodlands (Braby 2000). Adults typically fly high (above 3 m), with a fluttering and sailing flight.

**Observations**

On 11 November 2017 at 12:29h AEST, a male *D. harpalyce* was observed, for less than 5 minutes, flying around a patch of mature Black Wattles, *Acacia mearnsii* De Wild., at Bryton Wood, Moorak, 5 km SW of Mt Gambier in the lower south-east of South Australia [37°52'30"S, 140°44'28"E]. The locality is a privately owned 6 ha hobby farm, of which 50% has been planted with local native species, a house garden, firewood plantations and open recreation areas. Since 1997, over 60 species of native plants have been planted, including a range of eucalypts and acacias. The property is located 4 km from the nearest remnant patch of vegetation and is not connected to other properties, apart from the adjoining property to the west with revegetation (which was planted before 2000). The specimen was initially seen in the south of the property, flying in the open with a light wind blowing from the south but protected among eucalypts and acacias. Subsequently, a closer view was made when the butterfly fluttered low around the foliage of the patch of mature *Acacia mearnsii*, on which it landed less than 1 m from the ground, enabling a photograph to be taken (Fig. 1).



**Fig. 1.** Male *Delias harpalyce* settled on foliage of *Acacia mearnsii* at Bryton Wood, SA, 11 November 2017.

### Discussion

It is well known that *D. harpalyce* migrates and makes temporary extensions beyond its breeding range (Braby 2000, 2016) and Braby (2005) noted that individuals occasionally recorded from the mallee in the far north-west of Victoria are believed to be vagrants/migrants dispersing beyond the breeding range. Braby and Douglas (1992) documented a range of mistletoe food plants (and their host trees) for *D. harpalyce* in Victoria but, although some of these host trees are present on the Bryton Wood property, all known mistletoe food plants are absent from the site.

During a period of above average rainfall in 2010-2012, numerous butterfly species that are otherwise absent in the south-east of South Australia were observed, including *Papilio demoleus* Linnaeus, 1758 (Chequered Swallowtail), *Acraea andromacha* (Fabricius, 1775) (Glasswing), *Polyura sempronius* (Fabricius, 1775) (Tailed Emperor) and *Eurema smilax* (Donovan, 1805) (Small Grass-yellow). Similar influxes of 'out of normal breeding range' records of butterflies in SA have been associated with high rainfall events in the past, particularly during the years 1917, 1955 and 1974

(Haywood 2014). However, the observation of *D. harpalyce* was well outside the most recent high rainfall event. The specimen was most likely a vagrant that had dispersed well outside its normal breeding range in western and southwestern Victoria. It is possible that weather conditions (especially wind direction) prior to 11 November 2017 influenced its movement into South Australia. Hill (2011) indicated that suitable warm, northerly airflows coincided precisely with the nights of several peak catches of *Utetheisa pulchelloides* (Hampson, 1907) in northwestern Tasmania from mainland origins and Hill (2016) displayed how catches of *Meyrickella ruptellus* (Walker, 1863) occurred within 1-4 days of suitable airflows for their carriage across Bass Strait. The wind direction from Cape Otway and Port Fairy to Portland in western Victoria, from 8-11 November, was in an E and/or SE direction (BOM 2018) and of moderate strength (>15 km/h), which could have assisted movement from east to west (Fig. 2).



**Fig. 2.** Map showing distribution of *Delias harpalyce* (source: Atlas of Living Australia (ALA) 2018: red circles), including location of coastal weather stations and the SA observation at Bryton Wood, Moorak. Note that ALA data points are often unverified and should not be regarded as definitive [cf. Dunn and Dunn 1991 and Field 2013].



## Acknowledgement

Thanks to Michael Braby for encouraging this observation to be reported. The butterfly observed was saved from capture by my Border-collie (Poppy), who distracted me momentarily and enabled it to flutter off without being collected.

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***RHYACOCNEMIS GASSMANNI* SP. N. (ODONATA: PLATYCNEMIDIDAE), A NEW IDIOCNEMIDINE DAMSELFLY FROM PAPUA NEW GUINEA**

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## Abstract

A new species of damselfly, *Rhyacocnemis gassmanni* sp. n. from Papua New Guinea, is described and illustrated from both sexes with notes on its habitat and habits. It represents the fourth species of an enigmatic genus, known from only a handful of specimens. The placement of the new species is problematical and is discussed.

## Introduction

The zygopteran family Platycnemididae includes well over 400 species widely distributed in the Old World. The majority are small and slim in build but there are many exceptions. Recent studies on the higher classification of the suborder Zygoptera (Carle *et al.* 2008, Dijkstra *et al.* 2014) have resulted in many changes to a long accepted status quo. In order to spare the reader possible confusion when consulting even quite recent literature we begin by clarifying the latest changes relevant to the present study.

Firstly, all old world Protoneuridae, including the largely Australian and New Guinean genus *Nososticta* Selys, 1860, have been transferred to the platycnemidid subfamily Disparoneurinae (*cf.* Theischinger and Hawking 2006). Secondly, based on molecular analysis, Dijkstra *et al.* (2014) established the subfamily Idiocnemidinae to include all other platycnemidid genera occurring in the Moluccas, New Guinea and the Solomon Islands, as well as the highly speciose Philippine endemic genera *Risicocnemis* Cowley, 1934 and *Igneocnemis* Hämäläinen, 1991. The rich eastern fauna of this group, represented by 15 genera, is believed to have originated from the Philippines, dispersing along now submerged island arcs from about 25 million years b.p. (van Tol and Gassmann 2005). Idiocnemidines frequently, but not invariably, possess distinctive crenulate margins at the tips of their wings. Prior to the revision of Dijkstra *et al.* (2014), various authors (Gassmann 2005, Orr and Kalkman 2010, Orr *et al.* 2012) placed genera of this group in the Calicnemiinae, a subfamily now regarded as exclusively belonging to the Oriental Region.

Kalkman and Orr (2013) provided a checklist of New Guinean species that observed the currently accepted higher classification but the species list is now out of date, owing to the discovery and naming of several new species-

group taxa within established genera (*e.g.* Orr *et al.* 2014, Orr and Richards 2014, 2017, Kovacs *et al.* 2015). Without exception, these new taxa have presented no difficulties with regard to generic placement and in most cases relationships with established species are reasonably clear. However, in 2016 the second and third authors collected a small series of specimens of a new idiocnemidid species from small streams in the Purari River basin in Gulf Province, south-central Papua New Guinea, that does present some problems of generic placement. After due consideration, we describe it here as *Rhyacocnemis gassmanni* **sp. n.** The choice of genus, as well as our decision to not erect a new genus, is discussed. Terminology primarily follows Watson *et al.* (1991), augmented by Westfall and May (2006) where necessary. The presence of an additional postnodal crossvein in the costal space only is indicated by a fractional count (*e.g.* Px 14.5 etc.). Locality coordinates were recorded using the datum WGS84 and are given in decimal degrees. All type material is deposited in the South Australian Museum (SAMA) and each specimen has been allocated an individual accession number (see below).

***Rhyacocnemis gassmanni* sp. n.**

(Figs 1-2, 3a-f, 4a-e)

*Material examined.* Holotype ♂: PAPUA NEW GUINEA, Gulf Province, 'Unnamed site 3', -7.4911°, 145.2189°, 130 m asl, 2 Feb 2016, leg S.J. Richards and P.S. Toko. SAMA 07-001546. Deposited in the South Australian Museum SAMA, Adelaide. Paratypes: 3 ♂♂, SAMA 07-001547, 07-001548, 07-001549, 2 ♀♀, SAMA 07-001550, 07-001551, all same locality, date and collectors. All deposited in SAMA.

*Diagnosis.* A small, slightly built damselfly (Figs 1-2); ground colour dark with pale markings on the head, thorax and most abdominal segments, especially prominent on the broad terminal segments in the male. Pale markings basically pale caerulean blue but those on male with greenish tinge, excepting the tip of abdomen where they are pure pale caerulean blue. Wings narrow with short, diamond-shaped pterostigmata, fairly open reticulation and distal margins only weakly crenulate. Legs moderately long, thin and extensively pale with long, fine, black spines. The species can be most easily recognised by its small size, fine build, distinctive pale coloured markings and the shape of the male appendages.

*Description of male holotype.* Head proportionally rather small and narrow (3.5 mm in width) in sagittal plane (Fig. 3a). Labium pale ochraceous, roughly pentangular; medium lobe with shallow 'V'-shaped incision about one fifth length of lobe; only extreme apex of lateral lobes and maxilla dark brown. Labrum and almost all of face from the level of the antennal sockets very pale caerulean blue (creamy yellow in preserved specimen), with exception of slight basal infuscation on mandibles, along anteclypeal border with labrum and extending into two small dark, teardrop marks across genae. Remainder of head from vertex back black with obscurely defined, although large, postocular pale marks, these probably absent when fully mature.



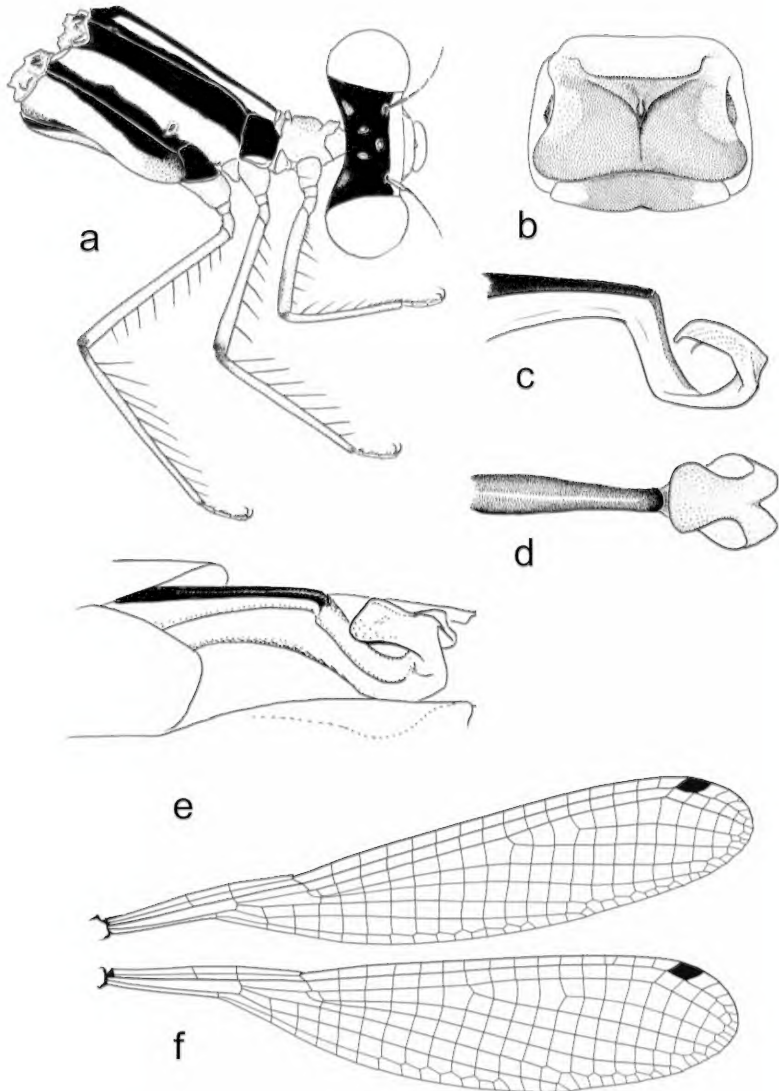
**Figs 1-2.** *Rhyacocnemis gassmanni* sp. n. in life: (1) male; (2) female.

Antennae black; scape, pedicel and flagellum all relatively long and thin. Eyes prominent, dark above, pale greyish white beneath in life (*cf.* Fig. 1).

Prothorax lacks strongly defined sculpturing and is rather uniform in profile (Fig. 3a); anterior lobe pale, distinctly raised in profile with well-defined groove delimiting it from median lobe; median lobe dark above (*cf.* Fig. 1), with sides mainly pale (dark marking often faded in preserved specimen);



posterior lobe dark with pale corners, slightly raised, of moderate width (Fig. 3a); in dorsal view weakly expanded medially and slightly incised medially on posterior margin (Fig. 3b).



**Fig. 3.** *Rhyacocnemis gassmanni* sp. n., holotype male: (a) detail head dorsal and thorax lateral; (b) prothorax in dorsal view; (c) penis lateral; (d) penis dorsal; (e) oblique ventral view of penis in situ; (f) wings, showing outline and venation.

Synthorax: mesepisternum marked with antehumeral band, broader anteriorly and tapered posteriorly, terminating well before antealar triangle (Fig. 3a), pale greenish in life (*cf.* Fig. 1). Laterally with uniform pale greenish band running full length of metepisternum, including spiracle but not quite reaching interpleural suture; similar parallel band on mesepimeron separated from pale area on venter by obscure dark line along intersegmental suture. Mesoinfraepisternum and metainfraepisternum dark, except for narrow patch bordering coxa on former.

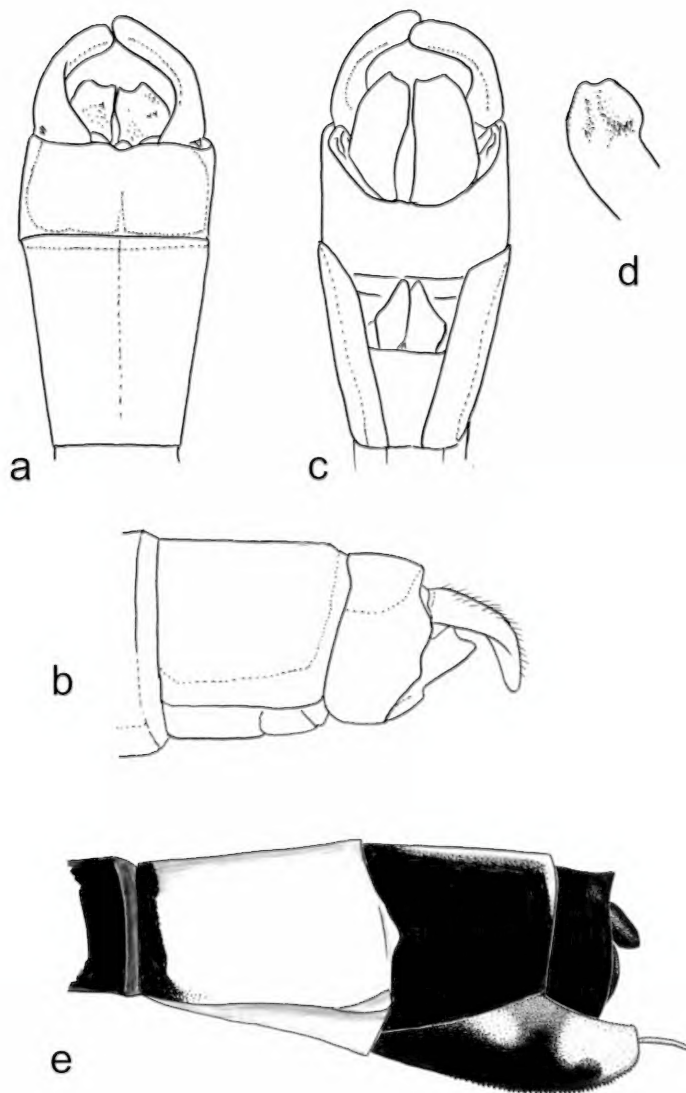
Legs (Fig. 3a) moderately long and thin, bearing long fine spines; hind femur reaching to about mid-point of abdominal S1; coxa pale in all legs; femora and tibiae pale with dark marking on posterior margin and at knees, more apparent in life (*cf.* Fig. 1) than in preserved specimen; tibiae dark with some pale marking; tarsal claws apically bifid.

Wings narrow, hyaline with black neuration (Fig. 3f); petiolated to just before level of Ac; Ac midway between Ax2 and Ax1; Arc level with Ax2; M3 arising about level of nodus; Rs arising just beyond nodus, never meeting M3; Px forewing, 15.5; Px hindwing, 15.5; quadrilateral in forewing *ca* 5.4 times as long along posterior margin as wide at base; in hindwing corresponding ratio *ca* 5.6 times; wing margin in both wings only weakly crenulated from point where M3 meets margin to level of pterostigma; pterostigmata in both wings rhomboid and dark sepia.

Abdomen long and thin, expanded from S8-S10, especially evident in dorsal view; mainly dark with well-defined pale greenish blue to blue markings (*cf.* Fig. 1; in preserved specimen pattern is less well defined owing to fading of dark background); S1 with broad lateral pale patch; S2 with small dorsal median pale patch and broad ventrolateral streak outlining genital fossa; S3 with small basal lateral pale spot and complete pale ring, broader beneath, well short of apex; S4 similar but basal mark extensive and subapical mark smaller and incomplete on dorsum; S5 similar but basal mark still longer and subapical mark very small, confined to venter; S6 similar but subapical mark obscure; S7 unmarked except for slight ventrolateral pale area basally. S8 distal one third dorsolaterally pale caerulean blue, this colour extending almost to base along the ventral margin. S9-S10 entirely pale caerulean blue dorsally except for fine black margins, apically on S9, basally and laterally on S10; both segments ventrally dark.

Appendages dark (Figs 4a-d). Superiors moderately thickened basally, thence thin and slightly flattened in the vertical plane, bending downward and inward from just before midpoint so that the tips meet; *ca* 1.4 times length of abdominal S10. Inferiors about half length of superiors, robust, subquadrate and slanting upward, terminally with shallow excavation in dorsal and ventral views; inner face with distinct, rounded terminal nodule in lateral view (Fig. 4d). Genital valve on venter of S9 large, *ca* 0.4 times length of segment, narrow and angular. Penis as illustrated (Figs 3c-e); narrow in ventral view

with glans a simple spoon, not divided apically and not quite reaching tip of shaft. Seminal vesicle long and narrow, *ca* 4 times as long as broad, completely concealing glans, dark in colour.



**Fig. 4.** *Rhyacocnemis gassmanni* sp. n.: (a-c) male terminal abdominal segments and appendages: dorsal, ventral and lateral views respectively; (d) inner oblique view of male inferior appendage; (e) terminal female abdominal segments and appendages.

Measurements: forewing, 19.8 mm; hindwing, 19.0 mm; abdomen + appendages, 30.7 mm.

*Variation in male paratypes.* Very little variation is evident except for slight differences in measurements and Px counts as follows: forewing 19.2-20.0 mm, Px 13.5-14.5 (in two cases with an additional supplementary Px in costal space); hindwing 18.3-19.5 mm, Px 12.5-14.5. The three male paratypes all had lower Px counts than the holotype, which was selected on the basis of its state of preservation.

*Female.* Habitus in general similar to male but slightly darker with proportionally shorter, stouter abdomen and other differences as noted below. In life (Fig. 2), pale markings everywhere pale caerulean blue to whitish, never with green tinge as found in male. Head as in male but labium mainly dark with pale border, postclypeus with well defined central dark ovate spot, pale postocular spots large and clearly defined. Thorax as in male; venation of wings similar; Px forewing, 14.5; Px hindwing, 13-14. Abdomen (detail of terminus, Fig. 4e): markings follow the same pattern as in male but are everywhere reduced in extent with basal pale making restricted to ventral corner and, unlike in male, well developed on S7; S8 completely blue apart from narrow basal black ring; S9 blue marking reduced to narrow streak along dorsum and broadly around dorsoapical margin; S10 entirely black, very short, posterior margin slightly pinched to form a dorsal crest; cerci short and conical, depressed; tubercle just visible in lateral view. Valve of ovipositor broad and extending just beyond level of tips of cerci; distal two-thirds of ventral margin armed with strong teeth; stylus long (slightly longer than cercus); well defined apical pale marking.

Measurements: forewing, 19.2-20.0 mm; hindwing, 18.4-19.0 mm; abdomen + appendages, 27.1-28.7 mm.

*Etymology.* *gassmanni*: a noun in the genitive case and named in honour of Dr Dirk Gassmann, in recognition of his seminal contributions to the systematics of platycnemidid damselflies, especially in New Guinea.

### **Habitat and biology**

The new species was found in lowland rainforest where individuals perched on low foliage in sunny patches along narrow (< 5 m wide), steep-sided and clear-flowing streams with a predominantly rocky substrate and extensive canopy cover (Fig. 5). Adults appeared to spend most of their time high in the canopy, dropping down to perch on vegetation adjacent to, or hanging over, the streams for short periods. None was found in swampy habitats or along larger rivers and streams with more open canopy. This species is known only from the Purari River basin in southern Papua New Guinea.

### **Discussion**

The genus *Rhyacocnemis* Lieftinck, 1956, was established to accommodate a single species, *R. sufficiens* Lieftinck, 1956, known from two males from



Goodenough Island taken at an altitude of around 1600 m. In erecting a new genus, Liefstinck (1956) placed particular emphasis on the form of the male appendages, with the superiors curving to meet at their tips and inferiors degenerate. Other features included the fine build, long legs, narrow penis and narrow pointed wings with relatively open venation and only moderate terminal crenulation of the apical margins. The second species assigned to this genus was *R. prothoracica* Liefstinck, 1987. This species was described from a single specimen from an altitude of 500 m in Morobe Province. The species was published posthumously (Liefstinck 1987), being finalised and submitted by Jan van Tol. No justification was given for its generic placement other than a similarity in wing shape and venation and general facies to *R. sufficiens*; its anal appendages differ strongly from those of *R. sufficiens*. Subsequently, Gassmann (2005) transferred *Idiocnemis leonorae* Liefstinck, 1949, the type male of which was collected from 1500-2000 m a.s.l. in the Huon Gulf (Liefstinck 1949), to *Rhyacocnemis* on the basis of its male appendages, which bear some similarity to those of *R. sufficiens*, and presence of an inner protrusion on the glans of the penis; a similar feature was illustrated for the penis of *R. sufficiens* by Liefstinck (1956) but the condition in *R. prothoracica* remains unknown. However, it is certain that *R. prothoracica* does not belong in any other established idiocnemidine genus.



**Fig. 5.** Habitat of *Rhyacocnemis gassmanni* sp. n. at the type locality.

In assigning *R. gassmanni* to a genus, we were faced with a problem. By the same criteria than Liefstinck (1987) assigned *R. prothoracica*, i.e. general facies, which include slender build, modest size, colour pattern, wing shape, venation and limited terminal crenulation on the wing tips, we can best assign

it to *Rhyacocnemis*. The male superior appendages approximate the condition found in *R. sufficiens* but this might well have arisen by homoplasy. The inferior appendage is well developed, unlike in *R. sufficiens*. It is about the same relative length as that of *R. prothoracica* but different in form. The penis does not closely resemble that of *R. sufficiens* or *R. leonora*. Indeed, it is most similar to that of *Idiocnemis lousiadensis* Lieftinck, 1958 and *I. leonardi* Lieftinck, 1958, both from the Louisiade Archipelago and figured by Gassmann (1999). This similarity, however, reflects a lack of characters and complex structure rather than any clear synapomorphy. Moreover, in other respects *R. gassmanni* is quite unlike these species. It differs from them in venation, notably in having significantly fewer postnodal crossveins as well as having much weaker crenulation at its wingtips; moreover, in colour pattern and the structure of its male terminal appendages, it is very different from any species of *Idiocnemis*. All other idiocnemidine genera are defined by clear apomorphies that are absent in *R. gassmanni*.

In the circumstances, there is a temptation to erect a new genus to accommodate this species. However, it is difficult at this stage to identify a single, clear synapomorphy that would reliably define a genus-group taxon. Our impression is that the species occupies a basal position in a subgroup of idiocnemidine genera sometimes referred to as the '*Paramecocnemis* group' (e.g. Michalski 2012). Indeed, Michalski (2012: fig 446) figured the terminalia of an undescribed species of *Parameconem* Lieftinck, 1932, which bear some similarity to those of *R. gassmanni*. However, *R. gassmanni* clearly lacks several definitive characters of *Paramecocnemis*, most recently redefined by Orr *et al.* (2012); hence, these are surely different taxa. Ultimately, the true phylogenetic position of *R. gassmanni* will probably remain uncertain until a molecular analysis of the group is available.

### Acknowledgements

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# **FURTHER NOTES ON SUBGENUS *TETRADACUS* MIYAKE OF *BACTROCERA* MACQUART (DIPTERA: TEPHRITIDAE: DACINAE), WITH A REVISED KEY TO SPECIES**

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## **Abstract**

Notes are provided for two species of *Bactrocera* Macquart subgenus *Tetradacus* Miyake described recently from Vietnam – *B. (T.) connecta* Leblanc & Doorenweerd and *B. (T.) ernesti* Leblanc & Doorenweerd, the former here transferred from subgenus *Asiadacus* Perkins. The response of *Tetradacus* species to the male lure zingerone is also noted and a revised key to the 10 known species is included.

## **Introduction**

The Indo-Australian subgenus *Tetradacus* Miyake of *Bactrocera* Macquart contains two citrus pests of biosecurity concern – *B. (T.) minax* (Enderlein) and *B. (T.) tsuneonis* (Miyake). The subgenus was treated as monophyletic and reviewed recently by Hancock and Drew (2018a) but the addition of two further species from Vietnam (Leblanc *et al.* 2018) has rendered the included key to species unworkable, thus hindering the ready separation of the pest species from others in the subgenus. A revised key is provided below and the two additional species are discussed, with one transferred from subgenus *Asiadacus* Perkins. Ten species of *Tetradacus* are now known, although the undescribed species from West Papua is possibly a variant of *B. (T.) mesonotochra* Drew from Papua New Guinea. The Vietnamese species noted above, plus at least one undescribed species from Papua New Guinea, were attracted to the male lure zingerone (Leblanc *et al.* 2018, Royer *et al.* 2018).

## **Genus *Bactrocera* Macquart**

### **Subgenus *Tetradacus* Miyake**

*B. (Tetradacus) connecta* Leblanc & Doorenweerd

*Bactrocera (Asiadacus) connecta* Leblanc & Doorenweerd, in: Leblanc *et al.* 2018: 99. Type locality Bach Ma National Park, Thua Tien-Hue Province, Vietnam.

*Distribution.* Central and southern Vietnam.

*Male lure.* Zingerone.

*Host plant.* None known.

*Comments.* This species belongs in Group B of Hancock and Drew (2018a) and most resembles *B. splendida* (Perkins) from Java, differing primarily in the shorter antennal scape and pedicel. Its subgeneric characters, including the comparatively short posterior surstylus lobe (less than half surstylus width: see Leblanc *et al.* 2018 fig. 7), all place this species in subgenus *Tetradacus* as defined by Hancock and Drew (2018a). Transfer from subgenus *Asiadacus* to subgenus *Tetradacus* is not incompatible with the



molecular placements of San Jose *et al.* (2018, as ‘*Bactrocera* sp. 68’) and Leblanc *et al.* (2018), who placed it in a basal assemblage of *Bactrocera* species that also included other *Tetradacus* species and/or *B. (Apodacus) visenda* (Hardy), but not the clearly monophyletic subgenus *Asiadacus sensu* Hancock and Drew (2018b), which belongs in the *Zeugodacus* group of subgenera (Hancock and Drew 2018c).

*B. (Tetradacus) ernesti* Leblanc & Doorenweerd

*Bactrocera (Tetradacus) ernesti* Leblanc & Doorenweerd, in: Leblanc *et al.* 2018: 96.  
Type locality Bach Ma National Park, Thua Tien-Hue Province, Vietnam.

*Distribution.* Central Vietnam.

*Male lure.* Zingerone.

*Host plant.* None known.

*Comments.* This species belongs in Group A of Hancock and Drew (2018a) and, at least in abdominal shape, most resembles *B. minax* (Enderlein) from China, Nepal, Bhutan and NE India. Its inclusion in subgenus *Tetradacus* is not incompatible with the molecular placements of San Jose *et al.* (2018, as ‘*Bactrocera* sp. 73’) and Leblanc *et al.* (2018), who placed it in a basal assemblage of *Bactrocera* species that also included other *Tetradacus* species and *B. (Apodacus) visenda* (Hardy).

### Lure records

Male lure records for species of *Tetradacus* are scant but three – *B. (T.) connecta*, *B. (T.) ernesti* and *B. (T.) pagdeni* (Malloch) – have now been collected at zingerone, as has recently collected material from Papua New Guinea (Royer *et al.* 2018). This suggests that zingerone represents the main attractant for males within the subgenus, with only the type series of *B. (T.) superba* Drew & Romig known from cue lure traps. Records of *B. (T.) minax* at methyl eugenol include both sexes, are seasonal (Royer 2015) and were regarded by Hancock and Drew (2018a) as incidental.

### Revised key to *Tetradacus* species

Modified from Hancock and Drew (2018a).

- 1 Wing with costal band broadly expanded apically, reaching or crossing vein M only in apical section beyond DM-Cu crossvein; scutum with presutural lateral yellow vitta from postpronotal lobe and postsutural medial yellow vitta both absent or vestigial; postpronotal lobe yellow; abdomen with black longitudinal and medial markings on at least tergites III-V [northern India and Bhutan] ..... *B. (T.) brachycera* (Bezzi)
- Not as above; wing with costal band faint or absent, reaching or extending beyond vein M throughout its length, or ending in cells  $r_{4+5}$  well before vein M and at most weakly expanded at apex; scutum with

- presutural lateral yellow vitta from postpronotal lobe and postsutural medial yellow vitta usually present, if both absent or vestigial then postpronotal lobe red-brown or costal band faint or absent beyond cell sc (pterostigma); abdomen with or without black longitudinal and medial markings on tergites III-V ..... 2
- 2 Wing cells bc and c densely microtrichose only at outer corner of cell c; apex of vein  $A_1+CuA_2$  without a patch of dense microtrichia in both sexes ..... 3
- Wing cells bc (at least outer corner) and c both densely microtrichose; apex of vein  $A_1+CuA_2$  with a patch of dense microtrichia in males ..... 5
- 3 One or two pairs of supra-alar setae present; lateral postsutural yellow vittae not distinctly angled inwards anteriorly alongside suture; abdomen with sytergite I+II broad and not distinctly petiolate [southern China and Japan (Kyushu, Amamioshima Is)] ..... *B. (T.) tsuneonis* (Miyake)
- Supra-alar setae absent; lateral postsutural yellow vittae distinctly angled inwards anteriorly alongside suture; abdomen with sytergite I+II longer than broad and distinctly petiolate ..... 4
- 4 Wing with costal band broadly crossing vein  $R_{4+5}$  into at least anterior halves of cells br and  $r_{4+5}$  and distinctly darker apically; presutural lateral and postsutural medial yellow vittae present [southern China, Nepal, Bhutan and NE India] ..... *B. (T.) minax* (Enderlein)
- Wing with costal band very faint or absent beyond cell sc; presutural lateral and postsutural medial yellow vittae absent [central Vietnam] ..... *B. (T.) ernesti* Leblanc & Doorendeerd
- 5 Scutum with presutural lateral yellow vitta from postpronotal lobe and postsutural medial yellow vitta both absent or vestigial; postpronotal lobe red-brown; wing with costal band reaching vein M throughout its length and posterior half of wing largely fuscous; supra-alar and prescutellar acrostichal setae weakly present [eastern Indonesia: Halmahera] ..... *B. (T.) superba* Drew & Romig
- Scutum with presutural lateral yellow vitta from postpronotal lobe present; postsutural medial yellow vitta usually present, if absent or vestigial then postpronotal lobe yellow; wing with costal band narrow, not reaching vein M or whole wing largely fuscous; supra-alar and prescutellar acrostichal setae absent ..... 6
- 6 Fore and mid femora fulvous with large, elongate black patches on outer surfaces; face with a pair of elongate black spots filling antennal furrows ..... 7
- All femora fulvous without fuscous patches; face with a pair of oval to pear-shaped black spots not filling antennal furrows ..... 8

- 7 Antennal scape and pedicel distinctly elongate; hind femora entirely fulvous [Indonesia: Java] ..... *B. (T.) splendida* (Perkins)
- Antennal scape and pedicel not distinctly elongate; hind femora apically red-brown [Vietnam] ..... *B. (T.) connecta* Leblanc & Doorenweerd
- 8 Scutum fuscous; abdomen fuscous in females and with broad lateral fuscous margins in males; wing membrane extensively dark fulvous to dark fuscous [Solomon Is] ..... *B. (T.) pagdeni* (Malloch)
- Scutum with extensive red-brown areas; abdomen not as above; wing membrane at most with a pale fulvous tint ..... 9
- 9 Scutum red-brown without extensive fuscous markings; wing with costal band not crossing vein  $R_{4+5}$ ; abdomen with broad lateral fuscous margins in females and anterolateral dark markings in males [Papua New Guinea; *B. neopagdeni* Drew is regarded as a synonym] .....  
..... *B. (T.) mesonotochra* Drew
- Scutum red-brown with distinct fuscous markings; wing with costal band narrowly crossing vein  $R_{4+5}$  into cell  $r_{4+5}$ ; abdomen without distinct anterolateral dark markings in males [females unknown] [eastern Indonesia: West Papua Province] ..... Undescribed species

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## A NEW SPECIES OF *AENETUS* HERRICH-SCHÄFFER (LEPIDOPTERA: HEPIALIDAE) FROM NEW GUINEA

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### Abstract

*Aenetus bilineatus* **sp. n.** is described from a single male from an unknown locality in New Guinea and compared with males of related *Aenetus* Herrich-Schäffer species from Papua New Guinea, Indonesia and northern Australia. The holotype is worn but several diagnostic characteristics are readily identified in comparison with similar species. Comparative images of *Aenetus bilineatus* **sp. n.**, *Aenetus marginatus* (Rothschild, 1896 and *Aenetus sibelae* (Roepke, 1935), **comb. n.** are given.

### Introduction

The genus *Aenetus* was erected by Herrich-Schäffer (1855) for the Australian species *A. ligniveren* (Lewin, 1805) and currently comprises 32 species, including the species described here. *Aenetus* species are known from Indonesia, Papua New Guinea, New Caledonia and New Zealand, as well as from tropical, subtropical and temperate regions of Australia, where most species occur within the annual rainfall band of about 600 mm (Simonsen 2018, Grehan and Mielke 2018). The major regions of species diversity are Australia, with eighteen species (Simonsen 2018) and the island of New Guinea, with nine species (Nielsen *et al.* 2000). The species diversity of the New Guinea *Aenetus* fauna is likely to be under-reported, as indicated by differences within the *A. tegulatus* group that was previously thought to be a single species across New Guinea and Australia (Grehan *et al.* 2018). The present description for *A. bilineatus* **sp. n.** is the first new addition to the New Guinea fauna in 62 years.

### Materials and methods

The terminology used for genitalia and wing venation follows Dugdale (1994) and Simonsen (2018). The diagrams of wing venation and valvae were made by tracing photographs of the holotype using Adobe Illustrator CC.

The holotype of *Aenetus bilineatus* **sp. n.** and a specimen of *A. marginatus* (Rothschild) from the South Australian Museum were dissected by Ebbe S. Nielsen, in preparation for a revision of the genus prior to his death in 2001.

Abbreviations: SAMA – South Australian Museum, Adelaide; FW – forewing; HW – hind wing; HT – Holotype.

### Systematics

#### *Aenetus bilineatus* **sp. n.**

(Figs 1-4, 6)

*Type material.* Holotype ♂: 'New Guinea, 1928, Acc. 29225', E. S. Nielsen gen. slide. 2408 ♂ E. S. Nielsen (In SAMA collection, SAMA Database No. 31-016030).



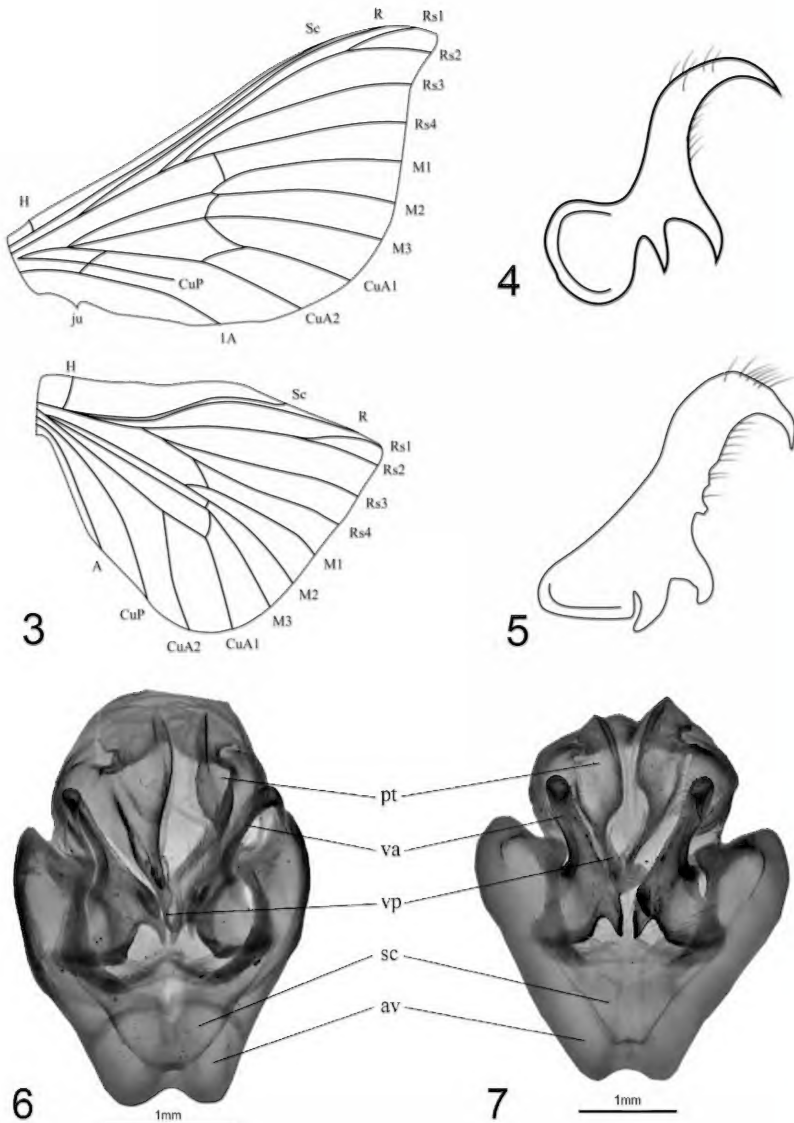
*Diagnosis.* This is the only known New Guinean species of *Aenetus* with combined features of both a strongly falcate forewing apex and distinctive medial and submarginal lines on the forewing in the male. The male genitalia, particularly the shape of the valvae, are unique. The very pale coloration and lack of green is distinct.

*Description.* Male (Figs 1-4, 6). Head: antennae longer than head and fine, filiform, pale brown. Eyes prominent, of roughly same height as head capsule. Scales on frons and vertex dense and cream-grey, obscuring base of antenna. Palps broken. Thorax: pro- and mesothorax dorsally and ventrally covered in fine pale grey-cream scales and interspersed with orange-pink and grey scales on ventral surface. Wings: FW length 36 mm, broad and triangular. Costa slightly concave centrally and convex towards apex. Apex noticeably falcate, with veins Rs2 and Rs4 extending further than Rs3 where meeting wing margin at apex. Wing venation classically hepialine (Fig. 3). HW: length 33 mm. Broad, triangular with sharp angle at apex and tornus. Dorsal FW ground colour uniformly cream-white with two transverse lines present; medial between inner margin at 1A and costa forming uninterrupted dark cream coloured line with proximal white highlights between veins Rs1 to well beyond CuA2 and submarginal between Rs2 and CuA2 as a dark cream line. Six light brown bars separated by white spots along costa with darkest bar distal to medial line. Faint mottled patterns of alternating lighter and darker cream colours near outer wing margin are difficult to distinguish from scale loss. Ventral surface with faint orange-pink piliform scales centrally and basally. HW dorsal surface white, costa and anterior margin marked a light grey interrupted line. Tornus and inner margin cream. Apex acutely pointed. Distal end of Sc curved convex towards costa, while R is distally straight. Posterior discal cell narrowly triangular, narrowing towards base. Basal area covered with white piliform scales. Legs uniformly grey-cream with orange-pink scales, small, narrow epiphysis on foretibia; hind leg with ochreous metatibial tuft of long androconial scales characteristic of *Aenetus*. Abdomen: only first two segments present, remainder probably removed during dissection and are missing, including S8. Segments covered in dense grey-cream scales dorsally and brown scales ventrally.

Male genitalia (Figs 4, 6): basal rim of pseudotegumen broad; dorso- and distoposterior margins of pseudotegumen smooth and rounded, curving medially halfway along rim of margin in posteroventral view; ventroposterior margin of pseudotegumen convex and smooth. Ventral pseudoteguminal arm small, short and pointed. Valvae large, narrow at proximal end, with broadly rounded sacculus. Viewed posteroventrally, the valvae curve laterally away from pseudotegumen. The tip of the valva ends as an evenly curved spine tapering to a sharp point, pointing vertically away from abdomen. When viewed laterally (Fig. 4) this spine is positioned almost horizontally with tip curving downwards. A second large downward-curving hook from middle of valva, curving proximovercally, a third, smaller, nearly straight hook



**Figs 1-2.** Holotype male of *Aenetus bilineatus* sp. n.: (1) dorsal view; (2) ventral view. (Photos © SAMA).



**Figs 3-7.** *Aenetus* spp: (3) wing venation of holotype of *A. bilineatus* **sp. n.** – venation terminology following Simonson (2018); (4-5) valvae of male: (4) *A. bilineatus* **sp. n.**; (5) *A. marginatus* (Rothschild); (6-7) dissected male genitalia, posteroventral view: (6) *A. bilineatus* **sp. n.** ESN gen. prep. 2408; (7) *A. marginatus*. (pt, pseudotegumen; va, valvae; vp, ventral pseudoteguminal arm; sc, saccus; av, apodemal vinculum). (Photos 6 and 7 © SAMA).

nearest to sacculus points vertically downwards and is less curved than other hooks. Fine hairs present between the two distal hooks and on tip of dorsal surface. Juxta flattened and U-shaped. Truellum membranous. Apodemal vinculum narrow and long, with paired posterior projections that are rounded and smooth. Saccus triangular, bilobed, narrow.

*Female.* Unknown. *Aenetus* species are often sexually dimorphic and the female of this species might not closely resemble the male.

*Etymology.* The name *bilineatus* (Latin) refers to the presence of the two lines (medial and submarginal) on the forewing. It was informally chosen by E. S. Nielsen and is retained here to honour his work on *Aenetus*.

*Distribution.* Simply provided on the label card as ‘New Guinea’, the exact location and collector are unknown. It is unclear if ‘New Guinea’ refers to Papua New Guinea or the Indonesian western half of the island. The biology and flight time are also unknown. Other members of this genus are known to be stem borers in woody plants, where they feed on callus tissue around the bore entrance, covered by a feeding web (King 1962, Grehan 1987). Collection and rearing of larval bores from different regions and habitats in New Guinea might yield further specimens of this and other *Aenetus* species.

***Aenetus sibela* (Roepke, 1935), comb. n.**

(Fig. 9)

*Phassus sibela* Roepke, 1935: 102.

*Endoclita sibela* (Roepke, 1935): Tindale 1958; Nielsen *et al.* 2000.

*Type material.* Holotype ♂: INDONESIA (MALUKU): ‘Sibela, Batjan ±2000 m, 20.8.1929. *Phassus sibela* n. sp. Rpk’ in Natural History Museum (Naturalis) Leiden. Image of holotype (Fig. 9) examined courtesy of Rob de Vos, Leiden.

Roepke (1935) provided a brief description of this species, which was collected as a pupal bore in the stem of an unidentified plant from ‘highland forest’ at around 2000 m from Buku Sibela, Indonesia, where the adult later eclosed on 20 August 1929. The ground colour of the type specimen has since faded to yellow but was ‘fresh green’ when newly emerged. Roepke originally placed the species in the New World genus *Phassus* Walker, 1856. Tindale (1958), without having examined the type, transferred *Phassus sibela* to *Endoclita* Felder, 1874 and Nielsen *et al.* (2000) followed that combination.

The species was brought to my attention by John Grehan (pers. comm.), who suggested that the correct placement was in the genus *Aenetus*, apparent to me after examining a photograph of the type specimen (Fig. 9). The light green wing and body colour, wing venation (unbranched forewing Sc and longer distal discal cell in HW, whereas *Endoclita* species figured by Zhu *et al.* (2004) have the proximal cell longest), white, rounded HW and the broad FW shape and pattern is consistent with that of most tropical *Aenetus* species



and I therefore propose its correct taxonomic placement as *Aenetus sibela* **comb. n.** The falcate FW shape and presence of superficially similar medial and submarginal lines on the forewing also suggest that the species is closely allied to *A. bilineatus* **sp. n.** and that the two might form a species group with *A. marginatus* (Rothschild, 1896) (Fig. 8).



**Figs 8-9.** Similar *Aenetus* spp: (8) *A. marginatus* (Rothschild), male SAMA. (Photo © SAMA); (9) *A. sibela* (Roepke), **comb. n.**, holotype male. (Photo by Rob de Vos).

## Discussion

The external appearance of *A. bilineatus* **sp. n.** is similar to that of males of *Aenetus sibela* (Fig. 9), *A. marginatus* (Fig. 8) and the *A. tegulatus* group (*sensu* Grehan *et al.* 2018). The *A. tegulatus* group comprises *A. tegulatus* (Pagenstecher, 1888) from the Island of Ambon, *A. thermistis* (Lower, 1894) from northern Australia, *A. sumatraensis* Grehan, Witt & Ignatyev, 2018 from northern Sumatra and a complex of as yet undescribed species from New Guinea and the Lesser Sunda Islands (Grehan *et al.* 2018). Dugdale (1994) and Simonsen (2018) identified valve morphology and wing pattern and shape as species-specific characteristics and it is these features that are discussed and compared where possible with similar species. In *A. bilineatus* the HW medial discal cell is very narrow and narrowing towards the base, which differs from the wing figured in Simonsen (2018) for *A. splendens*, where this cell is asymmetrical and narrow at both ends.

*Aenetus sibela* is known only from the single male holotype that has not been dissected and whose genitalia therefore cannot be compared with those of *A. bilineatus*. However, the FW medial band of *A. sibela* consists of

a series of dark brown spots edged on the inner side with silvery white extending from Sc and R near the costa to just beyond CuA2, whereas in *A. bilineatus* the band is an uninterrupted dark cream line with white highlights on the inner side extending from Rs1 to just beyond CuA2. In *A. sibelae* the submarginal band consists of thin brown lines between each vein from Rs2 to CuA2, whereas in *A. bilineatus* these lines are dark cream with white highlights between Rs2 to just above 1A.

The FW apex of *A. bilineatus* is narrower than that of *A. sibelae*. There are six dark greyish cream bars along the FW costa in *A. bilineatus*, the darkest of which lies slightly beyond the beginning of the medial line, where the distal two spots almost meet. Only five such dark bars are present in *A. sibelae*, more obvious and dark brown, the basal two nearly fused and the distal final spot becoming faded at costal section of the submarginal band. The FW of *A. sibelae* has a complex network of light and dark green mottled pattern interspersed with darker brown marks, with prominent brown fringe marks. *Aenetus bilineatus* lacks this pattern except for very faint markings along the wing margins and has the background colour cream-white. The HW apex of *A. bilineatus* is more acute than that of *A. sibelae*, which is more rounded with a more curved Rs1 vein.

The FW of *Aenetus marginatus* (Fig. 8) has only a single (medial) band. In addition, the FW of *A. marginatus* is, in general, more falcate than that of *A. bilineatus*. A genitalia dissection of *A. marginatus* at SAMA shows species level differences from *A. bilineatus* (Figs 4, 6). In *A. marginatus* (Figs 5, 7), the anterior margin of the vinculum has more prominent lateral corners and the central apodemal suture is rounded rather than cornered as in *A. bilineatus*. The valvae of *A. bilineatus* also differs substantially in having a rounded sacculus, narrower and more sharply pointed valve spines, with the apical spine gradually tapering from the valva stem and the basal spine shorter than the medial spine.

Of the *A. tegulatus* group the genitalia are only described for both sexes for the Australian species *A. thermistis*, which was recently recognised as distinct from the New Guinea *A. tegulatus* by Grehan (2018) based on differences in internal genitalia of the female. The males of *A. thermistis* differ from *A. bilineatus* by the distoposterior margins of the pseudotegumen curving inwards along the rim of the margin in only a very minor way, not at all to the extent as in *A. bilineatus*. The ventral pseudoteguminal arm is absent, unlike in *A. bilineatus* where it is small and pointed. The hooks on the valvae of *A. thermistis* are comparatively short and with the base much broader, longer and overall more rectangular. The apodemal vinculum is also different, with a broad and squared-off base very unlike the paired distal projections that are present in *A. bilineatus*.

Externally, males of the *tegulatus* group, when known, have a much straighter FW margin and a pointed apex at Rs2. Veins Rs3 and Rs4 are

almost the same length in comparison with the apex, making the wing appear overall broad rather than narrow as in *A. bilineatus*. *Aenetus thermistis* in most cases possesses only a single medial band, from Rs1 to just beyond CuA2, where it is silvery green or sometimes white. Some specimens with an indistinct, much shortened submarginal line are known; however, this line is only between veins CuA1 to M2. Along the costa of male *A. thermistis* there are six dark brown bars of varying sizes, which become darker toward the apex, not unlike those of *A. bilineatus*. In some specimens the bars are merged, appearing like three larger bars. In all specimens examined of *A. thermistis*, the final bar terminates beyond the beginning of the first submarginal band.

The pale cream-white ground coloration of the holotype of *A. bilineatus*, although striking, might be faded. Although care has been taken not to speculate inappropriately, observation of many faded *Aenetus* specimens over time has led the author to reason that a newly emerged or non-faded specimen of *A. bilineatus* is probably white in background colour, distinct from the grass-green seen in males of the *A. marginatus* and *A. tegulatus* group. In addition, the faint orange-pink scales on the forewing underside, the thorax and the legs, suggests that, when freshly eclosed, this species has striking bright orange, pink or reddish highlights similar to those of the other species mentioned. Although the colour itself might have faded, care has been taken to ensure that presence and location of the diagnostic pattern elements on the wings are correctly recognised.

Although describing a species from just a single specimen is sometimes discouraged, the combination of characters observed in the holotype are not shared with any other species and the recent interest in *Aenetus* (Simonsen 2018, Grehan *et al.* 2018) led to the decision to provide this description. At the time of writing, no other specimens of *Aenetus bilineatus* could be located or were known to the author. The location of 'New Guinea' is vague and, as the holotype was collected around 90 years ago, this species is described now in the hope that it will inspire further collecting and research in New Guinea of this enigmatic genus of moths.

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